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Vol. CXXXIV.—No. 3488] LONDON: FRIDAY EVENING, NOVEMBER 3, 1922 [Price One Shilling By Inland Post 1s. 3d.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—

1. FLEXIBLE STEEL WIRE ROPE, GALVANISED and UNGALVANISED.
2. COPPER TUBING.
3. BUFFERS, WROUGHT IRON, and WASHERS for BUFFER SPRINGS.
4. AXLE-BOXES, MALLEABLE CAST IRON or CAST STEEL, for CARRIAGES and WAGONS.

Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvidere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock P.M. on Thursday, the 23rd November, 1922.

T. RYAN,
Director-General.

617

Architectural Assistant REQUIRED by the GOVERNMENT of HONG KONG, for service as an Engineer in the Architectural Office of the Public Works Department for a period of three years, with possible permanency. Salary £480, rising to £500 per annum, and thereafter, if appointment made permanent, to £600 per annum by annual increments of £20. The salary is converted into dollars at the Government rate of exchange, at present fixed at 2s. to the dollar, but this rate is open to revision. Conveyance allowance of 240 dols. per annum. Free passages provided.

Candidates, unmarried, 25 to 30 years of age, must be architects' duly qualified assistants and belong to the R.I.B.A. or possess some equivalent diploma. Must be conversant with all the usual routine of an architectural office, including the preparation of sketch designs and working drawings, specifications, quantities, measuring, &c., in connection with new buildings, additions and alterations. Should also have had experience in the design and execution of steel and reinforced concrete structures. Some experience in the maintenance of buildings is desirable, and municipal experience preferred.—Apply at once by letter, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/11,544. 672

First-Class Structural DRAUGHTSMEN are REQUIRED at H.M. Office of Works, with good theoretical and practical training in calculations, practical details and drawings for Steel-framed Buildings and other Structural Steelwork. Only competent designers with at least three years' designing experience in steelwork contractors' works will be considered.

Reply by letter, stating age, military service (if any), experience and salary required, to ESTABLISHMENT OFFICER, H.M. Office of Works, Storey's-gate, S.W. 1. 642

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that CHARLES CAMPBELL WORTHINGTON, a citizen of the United States of America, of Dunfield, County of Warren, State of New Jersey, U.S.A., SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 182,811, entitled "Improvements in and relating to Means for Raising and Lowering the Cutter Bars of Lawn Mowers."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on the 25th October, 1922.

Any person or persons may give notice of opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS,
Comptroller-General.

611

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for : COPPER FIRE-BOX PLATES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 1st November, 1922.

A fee of £1 1s. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Tuesday, 14th November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. R. WYNNE,
Managing Director.

631

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for : WHEEL LATHE.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 30th October, 1922.

A fee of £1 1s. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Friday, 10th November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. R. WYNNE,
Managing Director.

659

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for : DUPLEX VERTICAL BORING AND TURNING MILL.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 2nd November, 1922.

A fee of 10s. 6d. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Tuesday, 14th November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. R. WYNNE,
Managing Director.

676

East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 15th November instant, TENDERS for the SUPPLY of—

LAMINATED SPRINGS AND BACK PLATES.

Copies of the specification can be obtained at the Company's offices on payment of £1 1s each. This fee will not be returned.

C. E. LILLIE,
Secretary.

73-76, King William-street,
London, E.C. 4,
1st November, 1922. 674

The Engineer

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The New Battleships.

Modern Blast-Furnace Practice.

Care and Maintenance of Diesel Engines.

PUBLIC NOTICES

Administrative County of London.

The London County Council invites TENDERS for FIVE SETS of VERTICAL ENCLOSED STEAM ENGINES direct coupled to CENTRIFUGAL PUMPS, and TWO INDEPENDENT CONDENSING SETS, for Abbey Mills Pumping Station, Abbey-lane, Stratford, London, E. 15. The total pumping capacity of the five sets is to be 54,000 gallons a minute.

Persons desiring to tender may obtain on and after Monday, 6th November, 1922, the drawings, specification, form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, Charing Cross, S.W. 1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender, and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected at the Old County Hall before the payment of the fee.

No Tender received at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 27th November, 1922, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council.

677

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 22nd November, TENDERS for the SUPPLY of :—

1. CANVAS, BUNTING, &c.
2. INDIA-RUBBER HOSE, SHEETING, &c.
3. RED LEAD.
4. DOG SPIKES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
31.10.22. 684

County Borough of Reading.

SEWAGE DISPOSAL.

ACTIVATED SLUDGE TREATMENT WORKS.

The Corporation of Reading invite TENDERS for the CONSTRUCTION OF AERATION, RE-AERATION and SETTLEMENT TANKS, DETRITUS TANKS, SCREENING APPARATUS, CHANNELS, PIPE LINES and other Works at Manor Farm, Reading, in accordance with drawings, general conditions and specifications prepared by the Engineer, Mr. G. Midgley Taylor, of Messrs. John Taylor and Sons, 36, Victoria-street, Westminster, S.W. 1.

The general conditions, specification, schedule of prices, bill of quantities and form of Tender may be obtained from, and the drawings seen at, the office of the Engineer upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Sewage Disposal : Contract 2," must be delivered at my office at the Town Hall, Reading, on or before Friday, 24th November, 1922.

The Corporation do not bind themselves to accept the lowest or any Tender.

C. S. JOHNSON,
Town Clerk.

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PUBLIC NOTICES

Borough of Camberwell.

TO ENGINEERS, BOILERMAKERS AND LAUNDRY MACHINERY MAKERS.

The Council invite TENDERS for ONE NEW VERTICAL STEAM BOILER, ONE NEW HORIZONTAL STEAM CALORIFIER, ONE NEW HORIZONTAL STEAM ENGINE, NEW LAUNDRY MACHINERY, &c., in connection with the rearrangement of the Boiler-house and Service Laundry at the Public Baths, East Dulwich-road, East Dulwich, S.E. 22.

Specification and form of Tender can be obtained from Mr. Frederick J. Slater, Borough Engineer, Town Hall, Camberwell, S.E. 5.

Tenders, together with complete drawings and full particulars, must be delivered on or before Thursday, 30th November, 1922, not later than 5 p.m.

C. WILLIAM TAGG,
Town Clerk.

673

Brighton Parish.

The Guardians of the above-named Parish are desirous to receive TENDERS from persons willing to enter into a contract for the SUPPLY, DELIVERY, and SETTING at the Poor Law Institution, Elmgrove, Brighton, of TWO CORNISH BOILERS, each 28ft. long by 6ft. diameter, with working pressure of 150 lb., together with the REMOVAL of TWO existing CORNISH BOILERS and sundry BUILDERS' and ENGINEERS' WORK necessary to the alteration of the boiler-house.

Plans and specification, with form of Tender and conditions of contract, may be obtained upon application to the Guardians' Architect, Mr. E. Wallis Lone, M.S.A., M.I. Mun. E., 56, East-street, Brighton, on payment of a sum of £3, which charge will be refunded on receipt of a bona fide Tender.

Sealed Tenders, on the prescribed form, endorsed "Tender for Boilers at Poor Law Institution," must be delivered to the undersigned at the Parochial Offices, Prince's-street, Brighton, on or before Tuesday, the 21st November, by Ten o'clock in the forenoon.

The Guardians reserve to themselves the right to reject the lowest or any Tender.

By Order of the Guardians,
HORACE BURFIELD,
Clerk.

Parochial Offices,
Prince's-street, Brighton,
30th October, 1922. 653

Romford Rural District Council.

RIVERSIDE SEWERAGE.

CONTRACT No. 4.

PUMPING MACHINERY, AUXILIARY PLANT, &c.

The Council are prepared to consider TENDERS from approved makers of sewage pumping machinery for the CONSTRUCTION and ERECTION at their proposed Outfall Works adjoining Rainham Creek, Parish of Hornchurch, Essex, of the PUMPING MACHINERY and other PLANT required.

The Contract includes :—Centrifugal Pumps, Vertical Semi-Diesel Engines, Overhead Travelling Crane, Sludge Ejectors, Pipe Work, and all Auxiliary Plant and Accessories.

The whole will be let in one contract and all the principal parts must be British manufacture.

The general conditions, specification and drawings may be inspected at the office of the Consulting Engineer, Mr. William Fairley, M. Inst. C.E., Parliament Mansions, Westminster, S.W. 1, and a limited number of copies of the specification are available for issue to pump makers direct, on deposit of crossed cheque for £5 5s., made payable to the Council, which deposit will be returned on receipt of a bona fide Tender.

Tenders to be lodged with the undersigned on or before Monday, the 27th day of November, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

T. W. A. GREENHALGH,
Clerk to the Council.

24th October, 1922,
16a, South-street,
Romford, Essex. 665

PUBLIC NOTICES

State Electricity Commission OF VICTORIA.

TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification will be available upon application to—

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/5.—HIGH-PRESSURE STEAM, DRAIN AND FEED PIPING, VALVES, TRAPS, &c.

CHARGE.—£2 2s. for the first two copies complete with Tender forms, conditions of contract, specification and drawings. This charge is returnable on receipt of a bona fide Tender. A third or any further copies will be supplied for the sum of £1 1s. each, but this charge is not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is to be lodged with the Tender.

The specification may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 26th January, 1923.

R. LIDDELOW,
Secretary.

State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 650

State Electricity Commission OF VICTORIA.

TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification will be available upon application to—

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/3.—SWITCHGEAR AND ACCESSORIES.

CHARGE.—£2 2s. per set of three copies complete with Tender forms, conditions of contract, specification and drawings. This charge is returnable on receipt of a bona fide Tender. A fourth or any further copies will be supplied for the sum of 10s. 6d. each, but this charge is not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £25 is to be lodged with the Tender.

The specification may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m. on the 15th January, 1923.

R. LIDDELOW,
Secretary.

State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 660

State Electricity Commission of VICTORIA, AUSTRALIA.

COMBUSTION ENGINEER.

APPLICATIONS are INVITED for the POSITION of COMBUSTION ENGINEER in the Mechanical Engineer's Section from engineers having sound engineering training and extended experience in the economical burning of fuel with mechanical stokers in large water-tube boilers installation and well versed in the technology of fuel combustion and steam practice. Applicants should be methodical and keen, able initiate and direct investigation, and apply results therefrom, and generally direct testing staff in connection with performance of tests on boiler furnaces, steam turbines, condensing plant, pumps, &c. Headquarters will be in Melbourne. Salary at the rate of £600 per annum, commencing half-pay upon the day of sailing to Australia and full pay from the date of arrival in Melbourne. Travelling expenses for the voyage out will be allowed up to £150.—Applications, tabulating experience in chronological order, stating age and when available, with copies of testimonials, should be submitted not later than Friday, 10th November, 1922, to the AGENT-GENERAL for VICTORIA, Australia, Victoria House, Melbourne-place, Strand, London, W.C. 2. 593

Great Northern Railway (Ireland).

SALE OF OLD RAILS, SLEEPERS, &c.

The Directors are prepared to receive TENDERS for the PURCHASE of about :—

5000 TONS 18/26lb. OLD STEEL RELAYABLE FLANGE RAILS.

2400 TONS SCRAP METALS of various kinds.

Also 60,000 OLD SLEEPERS, 9ft. by 10in. by 5in.

Particulars and forms of Tender may be obtained on application to the undersigned, and Tenders should be delivered, under sealed cover, endorsed "Tender for Old Materials," not later than 10 a.m. on 15th November, 1922.

The Directors do not bind themselves to accept the highest or any Tender.

J. B. STEPHENS,
Secretary.

Amiens-street Station, Dublin,
28th October, 1922. 646

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PUBLIC NOTICES

State Electricity Commission
OF VICTORIA.

TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification may be obtained or inspected upon application to :—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/4.—STEAM TURBINE-DRIVEN BOILER FEED PUMPS.

CHARGE.—£1 1s. for the first two copies of Tender form, conditions of contract and specification complete. These charges will be returned on receipt of a bona fide Tender. A third and any further copies will be supplied for the sum of 10s. 6d. each.

PRELIMINARY DEPOSIT.—A preliminary deposit of £25 is required to be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m. on 10th January, 1923.

R. LIDDELOW,
Secretary,
State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 562

Romford Rural District Council.

The Council REQUIRE the SERVICES of a CLERK of WORKS to supervise the Construction of Outfall Sewer and Works at South Hornchurch, at a salary of £6 6s. per week.

Applications in writing, stating age, experience and references, to be made at once (endorsed "Clerk of Works"), to

T. W. A. GREENHALGH,
Clerk to the Council.

South-street, Romford. 538

SITUATIONS OPEN

WANTED, an ASSISTANT MANAGER for Small General Engineering Works on Tees-side. Must be a capable engineer and experienced in estimating and interviewing.—Address, with references and stating salary required, 530, The Engineer Office. 530 A

WANTED, Capable MECHANICAL COMMERCIAL ENGINEER, to Take Charge of Machinery Purchasing Department of export firm of merchants and contractors in London. Age 30 to 40 ; at least 5 years' progress experience in similar position accessary ; bachelor preferred. Application should state salary expected and give full details of previous experience, with copies of testimonials.—Reply to Box D 568, c.o. Dawson's Advt. Offices, 121, Cannon-street, E.C. 4. 642 A

WANTED, Young Energetic CIVIL ENGINEER to become Contractor's Agent on Sewerage Contract. Give full particulars and state salary required. —Address, 681, The Engineer Office. 681 A

ACCOUNTANT BOOKKEEPER WANTED for Constructional Engineers' Office in Westminster ; must be capable and good all-round man, industrious. State experience, age and salary required.—Address, 684, The Engineer Office. 684 A

AN Experienced ENGINEER is REQUIRED by a leading Insurance Company to undertake the duties of Engineer Surveyor in the Liverpool District. Applicants must hold a First-class Board of Trade Certificate, and be capable of examining all kinds of Steam Boilers and Engines, &c., and submitting accurately dimensioned sketches with clear and concise reports of same. Commencing salary £260 per annum. —Address full particulars to 645, The Engineer Office. 645 A

BRIDGE BUILDERS.—A Firm of Steel Bridge Builders WISH to GET IN TOUCH with a fully COMPETENT MAN capable of undertaking Cylinder Sinking, Concreting, Brickwork and Excavations for Abutments and Estimating Cost of same.—Address, 652, The Engineer Office. 652 A

ENGINEER TO TAKE CHARGE OF OIL ENGINE DEPARTMENT.—"Engineer," Friday, September 22nd, No. 283. Advertisers wish to THANK all APPLICANTS for the above post, which has now been FILLED. 654 A

ENGINEERING SALES CORRESPONDENT (Junior Sales Engineer) WANTED by City Office, American firm. Any salary in reason paid for the right man, who, however, must be a high-grade man of about 30, with a few years' experience in selling machinery, sales correspondence and engineering calculations. Preference will be given to a man of attractive and forceful personality.—Address, stating age, salary required and previous experience, 656, The Engineer Office. 656 A

JUNIOR ASSISTANT ENGINEER for Portuguese West Africa ; expert knowledge of Reinforced Concrete Design and fluent Portuguese essential. State age and brief particulars of all previous positions held.—Address, 686, The Engineer Office. 686 A

REINFORCED CONCRETE. — FIRST-CLASS DESIGNER REQUIRED, used to difficult work.— Address, stating age, experience and salary required, 678, The Engineer Office. 678 A

WORKS SUPERINTENDENT REQUIRED for small Engineering Shops in North London ; age 25-35. Only men who have served full time apprenticeship in fitting and machine shops, and have a thorough knowledge of drawing-office working need apply.

Some experience in Foundry Work will be an advantage. Salary about £5 per week, to commence, depending on experience.

Address, P6371, The Engineer Office. P6371 A

WANTED by a Firm of Laundry Engineers, Competent DRAUGHTSMAN Applications to state age, experience and salary required.—Address, 682, The Engineer Office. 682 A

WANTED, First-class DRAUGHTSMAN. One with experience in the Design of Woodworking Machinery preferred.—Write, stating age, salary and experience, to Box 2111, Willings, 50, King-street, Covent Garden, W.C. 2. 635 A

WANTED, First-class TRAMCAR DRAUGHTSMAN, capable of dealing with Trucks, Underframes, and full-size Body Lay-out, also General Detail Work. Works, Yorkshire.—Address full particulars re experience, salary, &c., 647, The Engineer Office. 647 A

WANTED, LEADING DRAUGHTSMAN for Office in London ; must have first-class experience in the Design of Electric Cranes.—Address, stating salary, age, experience, &c., 651, The Engineer Office. 651 A

DRAUGHTSMAN WANTED, Thoroughly Conversant in Design of all types of Centrifugal Pumps ; Glasgow district.—Apply, stating experience, age and salary required, Box No. 62, Brown's Advertising Office, 166, Buchanan-street, Glasgow. 649 A

FIRST-CLASS DRAUGHTSMEN REQUIRED for Aeronautical Work ; applicants must have had wide general, and preferably some Aircraft Experience —Apply, BRISTOL AEROPLANE CO., Ltd., Filton, Bristol. P6349 A

FIRST-CLASS DRAUGHTSMAN REQUIRED for Constructional Steelwork ; must have had previous experience in Preparing Working Drawings for Steel-frame Buildings, Roofs, &c. State age, previous experience and salary expected.—Address, 680, The Engineer Office. 680 A

SITUATIONS OPEN (continued)

GENERAL ENGINEERING DRAUGHTSMAN REQUIRED by Midland Engineering Firm. Good knowledge of Elevating, Conveying and General Mechanical and Structural Details essential. State age, detailed experience and salary required.—Address, 671, The Engineer Office. 671 A

JIG and TOOL DRAUGHTSMAN, with Good general Engineering Experience ; Operation and Lay-out Planning, Calculating Machining Times, &c. £5 per 41-hours week. London district.—Address, 669, The Engineer Office. 669 A

WANTED, Live, Competent FOREMAN for General Engineering Shop in Yorkshire, employing 70 men. Must be strict disciplinarian and not over 40. State age, salary required and full particulars of experience.—Address, 648, The Engineer Office. 648 A

FOUNDRY FOREMAN WANTED to Take Charge of Cast Iron and Brass Foundry in specialised Engineering Works.

Must have experience in Large Castings. Output, 50 tons per week.

State age, experience, and salary required.

Address, P6354, The Engineer Office. P6354 A

SITUATIONS WANTED

WANTED by a G.I.M.E. (Age 21), Passed A.M. exam., with works and university training, EXPERIENCE in DRAWING-OFFICE.—Address, P6361, The Engineer Office. P6361 B

A.M.I.C.E., A.M.I.E.E., Age 33, SEEKS POSITION of ASSISTANT to MANAGING DIRECTOR or other administrative post. Good technical and business experience, also five years on production work.— Address, P6362, The Engineer Office. P6362 B

AS WORKS MANAGER, Thoroughly Practical, Well-educated Engineer, sound shop and D.O. experience, loco., steam, general engineering, millwrighting, ironfoundry and repair work. Past 12 years successful control of labour as foreman and works manager.— Address, P6277, The Engineer Office. P6277 B

BOILERMAKER, PLATER. Good Experience, marking off, smith work, plate levelling, &c. (won silver medal, City and Guilds, for boilermakers' work), SEEKS SITUATION, home or S. Africa.— Address, P6390, The Engineer Office. P6390 B

B.SC., Diploma with Hnrs. Maths., 2 Months Iron-foundry and 3 months fitting shop experience, age 22 years, DESIRES OPENING in Heavy Electrical Engineering.—Address, P6358, The Engineer Office. P6358 B

B.SC. (Eng.), College Diploma, Stud. I.C.E., One year works experience, public school and ex-officer, age 23½, REQUIRES POSITION as Engineering Assistant.—Address, P6389, The Engineer Office. P6389 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.— Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 665 B

CIVIL ENGINEER, A.M.I.C.E., Public School, 30, married, two children, fed up with conditions of service in India, taking long leave in May, 1923, with object of getting permanent work in England. Experience 3 years waterworks in England, spent in tunnelling, pit sinking, pipe laying, preparation specifications and quantities, 15 years in India in charge survey, design and construction of large masonry weirs and earthen dams, river training and other works. Ready to take small salary at first in hope of full value within year ; outdoor work preferred. Could invest £1500 in a junior partnership.— Apply, ADVERTISER, 34, Parliament-street, S.W. 1. 601 B

CLERK of WORKS, SURVEYOR and DRAUGHTSMAN ; take charge new buildings, industrial, power-house, roads, sewers, housing, &c.; supervision of men and all works buildings.—49, Grahamroad, Wimbledon. P6350 B

CRANES, Excavators, Contractors' Plant, Structural Steel Work, &c.—ADVERTISER, with 20 years' exp. in charge new designs, construction, erection, quotations, correspondence, interviewing, manufacture SEEKS OPENING.—"SHOVEL," c/o Vincent and Co., 7, Upper Grove, S. Norwood, London. P6360 B

ENGINEER, A.M.I.C., M.I.M.E., with 25 Years' experience in mining, docks, railway and contractors' plant and machinery, is OPEN to REPRESENT a few FIRMS in South Wales.—Address, 639, The Engineer Office. 639 B

ENGINEER, MAINTENANCE (33), SEEKS BERTH abroad ; fluent Spanish, less exp. with refrig. steam and Diesel plants and the upkeep of mill and mine machinery ; highest refs.—Address, P6304, The Engineer Office. P6304 B

ENGINEER, to Take Charge of Heavy Oil or Gas Engines ; varied experience in shops, outside erection and repairs ; at present with leading makers. —Address, P6347, The Engineer Office. P6347 B

ENGINEER, Structural and General (35), 17 Years' experience, shops, D.O., commercial, and past 8 years WORKS MANAGER to large European firm in India, is DESIROUS of CHANGE ; energetic, excellent organiser, thoroughly experienced design, estimating and general engineering sales ; open to offer AT HOME OR ABROAD.—Address, P6356, The Engineer Office. P6356 B

ENGINEER (41), Working : Steam, Gas, Petrol engines, fitter and turner, repairs or new work ; had charge of saw mill and estate plant.—D. PHIM, Easthope, Much Wenlock, Salop. P6393 B

FULLY Qualified Mechanical Engineer and Designer (20 years' general engineering experience), is OPEN to ENGAGEMENT as Assistant to Consulting Engineer, whole or part time.—Address, P6381, The Engineer Office. P6381 B

JUNIOR ENGINEER (24), 8 Yrs. First-class Shop exp., good fitter, turner, and draughtsman, thoroughly conversant with steam and I.C. engines, good elect. knowledge ; accept any cap.—25, 30, Balfern New-road, Balham, S.W. 12. P6357 B

MAINTENANCE ENGINEER, Thoroughly Versed in steam and internal combustion plants and engineering in general, SEEKS POSITION anywhere abroad.—Address, WATTS and CO., 17, Johnson's-court, Fleet-street, London, E.C. 4. 634 B

MECHANICAL and ELECTRICAL ENGINEER (31) DESIRES POSITION of responsibility ; good training and university degree, expert mathematician and designer ; 7 years' experience in motor trade, accustomed to works management and control of workers ; energetic, resourceful, well recommended.— Address, 7, Duke-street, Pennfields, Wolverhampton. P6379 B

MECH. ENGINEER (31), Ten Years' Experience abroad, SEEKS any progressive APPOINTMENT, home or East ; workshops, steam and int. com. engines, erection and maintenance plant, construction ; sound organising ability, control labour ; excellent refs.—Address, P6392, The Engineer Office. P6392 B

SITUATIONS WANTED (continued)

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For continuation of Small Advertisements see page 3.

OCTOBER.

The Gliding Competition.

The gliding competition for a prize of £1000 offered by the proprietors of the *Daily Mail* took place on the Sussex Downs, near Lewes, from the 16th to the 21st of the month. Thirty-six entries, covering thirty-eight machines, were received for the contest, but not above 50 per cent. of the machines actually arrived, or, if they arrived, took to the air. The majority of the machines, both of those entered and of those which flew, were monoplanes. Few of them pretended to any great finish or finality of design. Indeed, in most instances they appeared to be somewhat hastily built makeshifts. Yet it cannot be denied that some remarkably fine performances were carried out, particularly so when the fact is remembered that most of the pilots, although well familiar with the flying of aeroplanes, had not previously had much, or in some cases even any, practice in the art of gliding. That art consists in taking advantage of the up draught on the face of a hill in order to recover the altitude lost during the true gliding periods, and is much more correctly designated wind flight than gliding. As practised during the competition, it was expressed as a series of to-and-fro beats or tacks away from and back towards the starting point, the longest distance flown from point to point being under four miles. Thus a glide of 3 hours 22 min., such as that performed by the winner, Maneyrolle, on the Peyret tandem monoplane, cannot be regarded as at all comparable with an aeroplane flight of the same duration. As a new form of sport, gliding will no doubt become popular with some, but from the commercial point of view it can obviously have no great future. On the other hand, it has been claimed for it that it has already on the scientific side revealed much of value to the aeroplane designer, while as a means of training aeroplane pilots it is understood to be engaging the close attention of the Air Ministry.

Synthetic Petrol.

Unlimited supplies of petrol were foreshadowed at the Congress on Liquid Fuels held in Paris during the month, when interest was centred most largely in the catalytic process of producing petrol from vegetable and animal oils discovered by Professor Paul Sabatier, of Toulouse. As it is estimated that all the known supplies of petroleum oils will be exhausted in about sixty years, it follows that the only real solution of the fuel problem lies in utilising the solar energy stored in vegetable products, of which the supplies are being constantly renewed. Experiments carried out during the past two or three years show that all kinds of oils, having exactly the same qualities as mineral oils, can be produced synthetically and, it is claimed, at a sufficiently low cost to make the system a commercial success. The catalysers are dehydrating and dehydrogenating metals and minerals, varying with the character of the oils to be treated, and the oils are passed over them at a temperature of about 600 deg. Cent. The first result is the separation of water and then of acid fats, leaving the resultant glycerine as a by-product. The molecules are dissociated and re-combined to produce any kind of oil having exactly the same qualities and characteristics as natural mineral oils. According to Professor Mailhe, who carried out the experiments with Professor Sabatier, the process of molecular dissociation and re-combination appears to be exactly the same as what is going on inversely in the earth to produce the various petroleum oils which vary according to the conditions of temperature and chemical reaction to which they are subjected. The catalytic process has definitely proved its value as a means of producing from vegetable and animal oils light fuels having all the qualities of natural mineral oils, and if, as is surmised, it can be worked commercially, it will have solved completely the problem of liquid fuels.

Breakages of Locomotive Connecting-rods.

Four times during the present year have locomotive connecting-rods broken in service and the fire-box been pierced. On each of three of these occasions an engineman was killed. The first of the four occurred on January 11th, on the Midland, and the Ministry of Transport report thereon was the subject of a Note for June in our issue of July 7th. The second occurred on April 28th at Cheadle Hulme, and the third a week later at Furness Vale—both on the London and North-Western Railway. In the last-named, there was no fatality. The fourth happened on May 27th at Manuel, on the North British Railway. The second and third were inquired into by Colonel Mount, the officer who conducted the Midland inquiry, and his report was issued on the 10th of the month. As with the Midland case, there was little or nothing to suggest that the failures were due to any neglect or inattention. As the Manuel accident has not been inquired into, we may assume that it also leads to no personal blame. That such is the case is very gratifying, as the war and post-war periods were very trying to locomotives, since repairs were perforce delayed or hurried. The two failures on which Colonel Mount has just reported do, however, indicate that connecting-rods need to be taken down and examined at regular intervals—preferably determined by the mileage run; that the lighting of engine sheds should be improved, and that the card system for drivers to report defects has advantages over the repairs book, inasmuch as a driver does not know what a predecessor has reported, and, further, recurring defects are less likely to be overlooked. It is due to the London and North-Western Company, which suffered two of these four misfortunes, that we should say that the report mentions that out of thirty-eight failures of connecting-rods during 1920 and 1921, only one was on that system.

Tests of Agricultural Machines.

The Ministry of Agriculture and Fisheries is endeavouring to put itself into such a position that if it be informed of the nature of a certain soil, it will be able to tell a farmer how best to treat it and what crops are likely to prosper best on it. In pursuance of this policy, it has for some time past been carrying out sets of experiments in various parts of the country. During the month, acting in conjunction with the Kent Agricultural Committee and the Kent Branch of the National Farmers' Union, it arranged for a demonstration of drainage and subsoiling machines to take place on a farm near Tonbridge. The demonstration was intended partly to draw attention to the steps which the Ministry is taking for the purpose of collecting reliable data regarding the cost and utility of farm draining and subsoiling machines, and partly to give farmers an opportunity of seeing such machines operating under actual service conditions. The machines seen at work included mechanical mole drainers drawn by cable sets and also by tractors; an American tractor ditch digger; and numerous types of subsoiling machines. With the latter an attempt is to be made to solve the question as to whether it is best—when dealing with the "hard pan" which forms in clayey soils as the result of years of cultivation—to invert the pan to the surface or to disturb or disrupt the pan without inverting it to the surface. Various plots of similar land were being treated by different kinds of machines, and it is proposed by observing the influence of the various methods on the physical properties and chemical contents of the soil, and also by carefully taking note of the quality and quantity of crops produced on those plots, to arrive at some definite conclusions in the matter. Authorities are not, at present, in agreement regarding the question, but it is hoped that the present investigations, which are to be carried out in a thoroughly scientific manner, will serve to elucidate it.

International Railways.

The meeting in Paris during the month of representatives of European railways, and the constitution of a permanent International Railway Union, marks the beginning of an attempt to bring order out of the chaotic condition of the transport service on the Continent. The discrepancies in money values in various countries has made it impossible to fix upon a stable basis for traffic charges. The railway systems are all suffering more or less from the effects of the war, and owing to the financial depression, many of them are lamentably deficient in rolling stock. There is also a lack of co-ordination and a want of systematic effort to secure greater unity in the working of continental railways. So serious are the obstacles in the way of reorganising international traffic that the task devolving upon the Railway Union is a formidable one; but for the first time all the countries are represented on a committee of management, which aims at bringing the international traffic back to its pre-war standard and even at improving upon that standard, if possible. Being in the hands of leading representatives of all the railways interested, the task is bound to be accomplished in time, and upon its success depends to a large extent the industrial revival of Europe, for there can be no steady recovery so long as traffic irregularities and restrictions and fluctuating rates hinder exchanges between different countries. The headquarters of the Union are in Paris. While its object is to investigate problems of international traffic and provide solutions, its recommendations, being made by official representatives, will necessarily be adopted by the countries concerned. It is, in fact, an expert organising commission which aims at making the best of the present conditions and progressively improving them until the difficulties that stand in the way of European transport are completely eliminated.

Currency and Trade.

The sudden heavy fall in the value of the French franc towards the end of October, coupled with the further collapse of the German mark, has had effects which show how closely trade expansion is bound up with financial stability. So long as the rate of exchange remains steady, the differences in money values do not stand in the way of business, since there is always a tendency for the prices of things to adjust themselves to those values, and the final result is a relative levelling up of prices and costs. When, however, the money values of a country suddenly fall, there is no immediate change in the purchasing power at home, but the cost of imported goods is proportionately increased, with the result that it becomes impossible to do business with countries where those conditions prevail. In France the impression is gaining ground that one of the principal factors in stabilising the exchange rate is the development foreign trade, which is the only way of reviving prosperity and creating confidence, and the pressure being brought to bear upon the French Government to negotiate treaties with other countries on a fair basis of reciprocity implies that there is likely to be a much more active foreign commercial policy in the early future. The powerful commercial groups in France are prepared to do their best to encourage trade with Great Britain. If the British trade associations co-operate with them in an endeavour to arrive at a sound commercial agreement, the result must be equally beneficial to both countries.

The Grouping of the Railways.

The announcement was made on the 20th of the month that the terms had been agreed for the amalgamation of the five interests that are to form the Southern Group of railways; on the 26th that the incorporation of the Furness, Glasgow and South-Western and Highland in the North-Western, Midland and West Scottish had been determined—no mention has yet been made of the North Staffordshire and Caledonian, which are also designated for that group—and on the 27th that the name of the combined company that takes the Eastern, North-Eastern and East Scottish lines is to be the London and North-Eastern Railway Company, and its chairman, Mr. William Whitelaw, at present the chairman of the North British. What we all are now waiting to learn is who are to be the chief officers of the groups. The appointment of Sir Henry Thornton as president of the Canadian National Railways—another event during October—removes a difficulty as to what post he should fill in view of the fact that Mr. Wedgwood, of the North-Eastern, obviously was to be the general manager of the Eastern Group. The amalgamation of the southern companies is physically a small matter compared with the Eastern and North-Western Groups. They are essentially passenger lines, and the extent to which this is so may be judged from the fact that in 1921 they carried 15 per cent. of the total passengers on English and Welsh railways. The three southern railways carried as many passengers as the London and North-Western and Great Western combined. The London and South-Western docks at Southampton form one of the greatest assets of the Southern Group, and they appear more likely to increase than diminish in importance.

The Liverpool-Manchester Road.

Last week at the Ministry of Transport Sir Henry Maybury, Director-General of Roads, presided over an important meeting of representatives of the Lancashire County Council and the county boroughs of South Lancashire to consider the Liverpool–Manchester road scheme, for which surveys and estimates have just been completed by the Ministry's staff. For the entire distance of 27 miles, a width of 150ft. between fences is contemplated, although actual road construction would be limited in the first instance to a paved carriageway 30ft. wide and two footways, leaving ample space for the subsequent duplication of the carriageway or any other developments which the growth of traffic might conceivably call for. After a lengthy discussion of the merits of the proposal, both from a traffic standpoint and as a means of alleviating unemployment, it was decided, on the movement of Dr. Utting, of Liverpool, to ask the Minister to consider the appointment of a small

committee, comprising one representative from the county and one from each of the county boroughs, in order to promote the speedy development of the undertaking.

The Wireless Exhibition.

THE first all-British Wireless Exhibition, which was held at the Royal Horticultural Hall from September 30th to October 7th, proved a great success from the point of view of attendance. There were, in fact, times when the building was very much overcrowded, and there is little doubt that the next exhibition of this kind will be held in a much larger building. For the most part the firms which were represented exhibited receiving sets for the reception of broadcasted music and news, but there were also transmitters and receivers for use in connection with aircraft, and an extensive display of component parts from which sets can be made. A great many amateurs appear to be making their own equipments with a view to saving expense and acquiring knowledge. Provided experimenters conform with the regulations which have been laid down by the Post Office concerning the use of reaction, there is no good reason why the production of home-made sets should be discouraged, but if amateurs be allowed to make sets which are capable of oscillating, then wireless telephony on the broadcasting wave lengths will not prove a success. Already many who are in the habit of listening to the concerts which are occasionally transmitted from Marconi House and elsewhere frequently experience interference from amateurs who energise their aerials. The manufacturers of wireless receivers are now bound, under the Post Office regulations, to construct sets which will not oscillate, but what steps are going to be taken to avoid the home-made equipments oscillating we do not know. It is obviously possible for an amateur to submit a circuit to the Post Office and get it approved, and then to use an entirely different circuit. Most of the wireless manufacturers are, as the exhibition showed, turning out quite good apparatus, and it is to be hoped that the Post Office and other bodies, such as wireless societies who desire to see the wireless broadcasting movement progress, will do all in their power to stop the use of improperly designed sets which may interfere with the operation of other sets in their immediate neighbourhood.

The Gravesend Collision.

ON the 25th of the month was issued the report of Major Hall to the Ministry of Transport on the accident in which two men were run over by a light engine and killed on August 21st at Milton Range Halt, South-Eastern and Chatham Railway, and on the collision which occurred ten minutes later between two workmen's trains at the same place, in which three passengers were killed or died from their injuries. The latter accident was due to the driver of the second workmen's train starting from Gravesend on a signal from his fireman who had received the authority to proceed from one of the station staff. The engine had already passed the starting signal when the train came to a stand in the station. That signal was at "clear," but the advanced starting signal, 450 yards or so further on, was at "danger." The driver did not see this signal, as he ran into a patch of fog, but his fireman gave him the "all-right" intimation. Owing to the fog near the halt, which had already led to the men from the first train being run down by the light engine, the driver of the second train did not see the first train—which was delayed to take some of the injured men to Strood—until it was only 15 yards off. The evidence at the inquiry showed that trains are seldom held at the advanced starting signal, and Major Hall said there could be little doubt that that fact had a distinct bearing on the case. Another factor was the lowering, by the signalman, of the starting signal before the train reached it. Where there are two or more stop signals at a signal-box and the starting signal is at "danger," the home signal is kept "on" until the train has reached it, and then it is lowered for the train to draw forward slowly towards the starting signal; when an advanced starting signal is "on," the starting signal is kept at "danger" until the train is at it. In this case the advanced signal was "on," but the signalman cleared his starting and home signals together. The advanced starting signal is fixed in a cutting where the conditions, at times, in respect of smoke and steam, approximate to those in a tunnel. Major Hall recommends, therefore, that the present semaphore signal be replaced by one of the daylight lamp type. The report concludes by saying that the collision was a typical example of the class of accidents which would be prevented by automatic train control in the form of a definite train stop at the advanced signal.

Metal Aeroplane Construction.

IT is a curious fact, one with, perhaps, considerable technical significance, that while in the case of airships wood quickly gave place to metal as the main material for the framing, the aeroplane, in spite of the much higher degree to which the technique of its construction has been developed, still makes use, in the vast majority of cases, of wood for most of the principal components of its structure. "All-metal" aeroplanes have, of course, been constructed in the past. A noteworthy British example of a machine of this description is the Short Silver Streak biplane, the first and so far the only example of which, purchased by the Government, is still, two or more years after its appearance, being tested and kept under observation at Farnborough. This machine, it will be recalled, is composed of steel, duralumin and aluminium, and is an "all-metal" machine in the fullest sense, even the usual fabric covering of the wings being replaced by thin sheet metal.

BOULTON AND PAUL'S "BOLTON" ALL-STEEL BIPLANE, COMPLETED

Abroad various designers have from time to time made essays in metal construction. An early example, the Clement-Bayard steel monoplane scout, was shown at Olympia in the spring of 1914. This machine, with the exception of the wing ribs, had a framework composed of steel, and, in addition, was armour-plated for a portion of its length on the underside of the fuselage. In the early days of the war, Professor Junkers, in Germany, turned his attention to the metal aeroplane, and in December, 1915, produced a machine with an all-steel framework, which was sufficiently successful to warrant its production in considerable numbers. Subsequently he developed his ideas in this direction to a remarkable degree, and before the war was over was producing machines with duralumin frameworks and with wing coverings of corrugated duralumin sheet. Other designers in Germany, taking their inspiration from Professor Junker's pioneer work, have also devoted close attention to the metal aeroplane, notable examples of their productions being the L.F.G. Stralsund monoplane and the huge four-engined all-duralumin Staaken monoplane turned out by the Zeppelin works. The latter machine is provided with duralumin wing coverings. In France, metal aeroplane construction has been closely studied, two recent productions being the Wibault duralumin night bomber and the Schneider all-steel machine. The Dutch designer, Fokker, has not as yet completely adopted the all-metal principle in any of his machines, stopping short at the wings, the framework of which he prefers to make of wood with, in some examples, a covering of three-ply instead of fabric.

Although it is doubtlessly true that the development of the all-metal aeroplane up to its present stage has been largely influenced by the shortage of suitable spruce and other timber in the later years of the war, it is not correct to imply that it owes its origin solely to that shortage, for efforts to produce an all-metal aeroplane were made almost from the first days of successful flight. It would not only be wrong historically to regard the origin in this light, but, in our view, wrong in principle as well. As in other branches of engineering in which wood has given way to metal as a structural material, the designer should not accept the one merely as a substitute for the other, but should seek to take advantage of all the special properties and characteristics of the new material without reference of too close an order to the constructional practice established for the old. We have to confess to a shade of disappointment in this respect, for in all the metal aeroplanes so far produced, even in the case of the all-steel system of construction which we are about particularly to deal with—that evolved by Boulton and Paul, Limited, of Norwich—it is evident that the technique of design and construction developed for wood is still influencing materially the use of metal. In this matter, however, we must not forget that the limits within which the aeroplane designer may vary his construction are drawn very narrowly by aerodynamical requirements, and that, wood or metal,

THE "BOLTON" ALL-STEEL BIPLANE WITHOUT COVERINGS

these requirements must be given prime consideration. In the design of a bridge, for example, the material can be disposed almost solely with a view to the development of maximum strength and substantially without reference as to how much space or what outline the finished structure will occupy. In an aeroplane, however, the absolute dimensions and the finished outline are in all important respects closely prescribed beforehand, and the designer has to accommodate the disposition of his structural material in accordance therewith.

In another important respect, too, the aeroplane designer is handicapped in his efforts to take full advantage of the superior primitive properties of metal as compared with wood. For the same weight of material he may design a metal member which is considerably stronger in the exercise of its prime

function than the corresponding wooden member would be. In the majority of cases, however, it is found that a large part of the possible increase of strength in the metal part has to be sacrificed, or alternatively the weight of the member has to be increased in order to provide the necessary resistance to locally—possibly accidentally—applied forces. This matter is capable of being, and has been, analysed mathematically, but it is sufficient for our purpose to illustrate it with the remark that a tubular metal strut may be designed which will, for the same weight, show three or four times the strength of a wooden strut of the same length, but which, by reason of the thinness of its walls, would collapse locally and fail as a whole if it suffered a kick or a light blow from a hammer or spanner.

These considerations, in our view, fully explain why the metal aeroplane, apart from the change of material, shows no important departure in its general system of construction from the machine built of wood. The advantages of adopting metal are, indeed, not such as to catch the eye on a cursory inspection of the machine. They include, of course, a definite increase of strength for the same weight, or, alternatively, a reduced weight for the same strength. It is, however, doubtful whether the importance of this advantage is not outweighed by the fact that the metal aeroplane is not susceptible to those climatic influences which in a wooden machine produce "sloppiness," and necessitate repeated trueing-up of the whole structure. This factor alone would justify the adoption of metal construction for military aeroplanes, especially for such machines operating in tropical or sub-tropical climates.

On the score of cost of construction little definite information is as yet available which would enable us to say on which side—wood or metal—the advantage lies. The development of all-metal systems of construction has admittedly been very costly; but—or at least in the Boulton and Paul system—it does not appear that there is anything inherently expensive in the methods employed. The rolling or drawing of the steel sections has been reduced to a workshop production basis, and is not uneconomical as compared with the working-up of spruce or ash. In the matter of the assembly of the structural parts, involving as it does at present reliance almost exclusively upon a large amount of fine hand riveting, the cost is relatively high. But economical riveting with suitable appliances operated by unskilled labour presents no serious problem, and is, in fact, well within sight. When production demands are such as to justify the adoption of improved means of riveting there is every promise that the all-metal aeroplane will be no more costly to build than a wooden one of the same capacity and performance.

One very important matter in the balance of advantages and disadvantages is the question of corrosion. While it is true that the all-metal machine does not suffer from the "sloppiness" produced in a wooden one by change of atmospheric conditions, it is, on the other hand, open to trouble from corrosion to an extent which exercises an influence on its design at many important points. The matter is of more than the usual moment because in the thin sections in which the metal is employed a relatively slight amount of corrosion will produce a substantial reduction in the cross section and strength of the parts affected. On the other hand, a protective coating applied to the parts may quite easily increase their weight to an almost prohibitive degree. In the majority of the all-metal machines mentioned above the material or principal material employed is aluminium alloy. The reason for using this metal is, in part at least, its enhanced resistance to corrosive influences and the fact that its low specific gravity permits its employment in sections the thickness of which is such as to afford not only good resistance to local failure but also a substantial reserve of metal to accommodate any loss of section by corrosion.

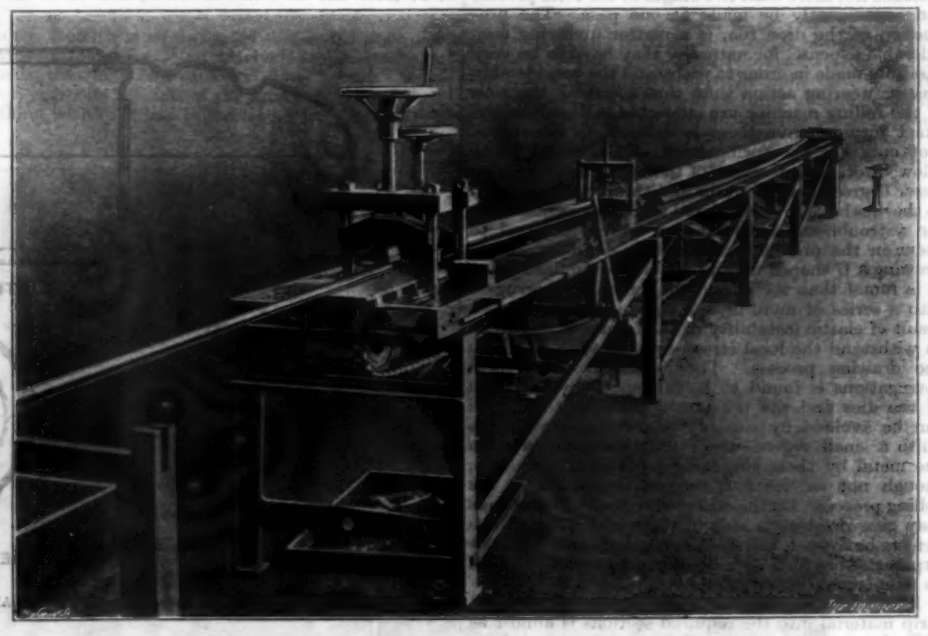
In the Boulton and Paul system of construction the principal metal at present employed is hardened and tempered nickel-chrome steel in thicknesses varying from 30 to 18 S.W.G.—0.0124in. to 0.048in. A protective coating is applied to the metal, but even so it is obvious that with such thin material the effect of possible corrosion must be a matter for serious consideration. In these circumstances it is interesting, though natural, to find that close attention is now being paid to the practicability of using stainless steel. Experiments, both in the direction of testing the corrosion-resisting properties of the metal and of drawing or rolling it to the required sections have, in fact, proved sufficiently satisfactory to justify the expectation that a stainless steel aeroplane will be constructed in the near future. The chief difficulty in the way—and even it is being overcome—is to obtain stainless material of a quality and in a condition that will submit to riveting, for it is obvious that there would be practically no value in using stainless steel for a member if the rivets uniting it were made of other than the same material.

By the employment of metal instead of wood, the firm believes that it is possible to reduce the structural weight of a machine from an average of 33 per cent. of the gross total weight in flying order to an average of 25 to 27 per cent. of the same amount. A saving of 5 or 6 per cent. in the structural weight of an aeroplane may not appear of very great amount, and certainly not sufficient to justify a very radical change in constructional practice. In reality, however, it is a noteworthy achievement, for it may mean an increase of as much as 25 per cent. in the available military load, and even more in the revenue-earning load in the case of a civil machine.

The steel at present being used is, as already stated, mostly nickel-chrome, and is received from the makers in a hardened and tempered condition. It has a tensile strength of about 85 tons per square inch, and is delivered to the works in coiled strips in various widths up to 6in. or 7in. and in any length desired. One important incidental advantage attending the use of metal is thus made apparent. The longest member desired—say, a fuselage longeron—can be made in one piece without the splice which is common in wood construction. The length of any member required is, in fact, practically unrestricted in metal construction, the only constructional limit being that imposed by the length of the bed of the drawing machine. This limit affects only those members which have to be drawn; it does not apply to rolled sections.

The material as received possesses a fair amount of spring, but not sufficient to prevent its being worked cold into various sectional forms. After rolling or drawing to the desired section the metal is not heat-treated, for with such thin material difficulties would be encountered in avoiding distortion. It is possible that later on the metal will be worked in the hot state, and subsequently heat-treated and tempered. At present, however, the majority of the structural members are made from springy nickel-chrome steel in the cold state, the only exceptions being certain portions, such as the leading edges of the wings,

REAR VIEW OF "BOLTON" ALL-STEEL BIPLANE

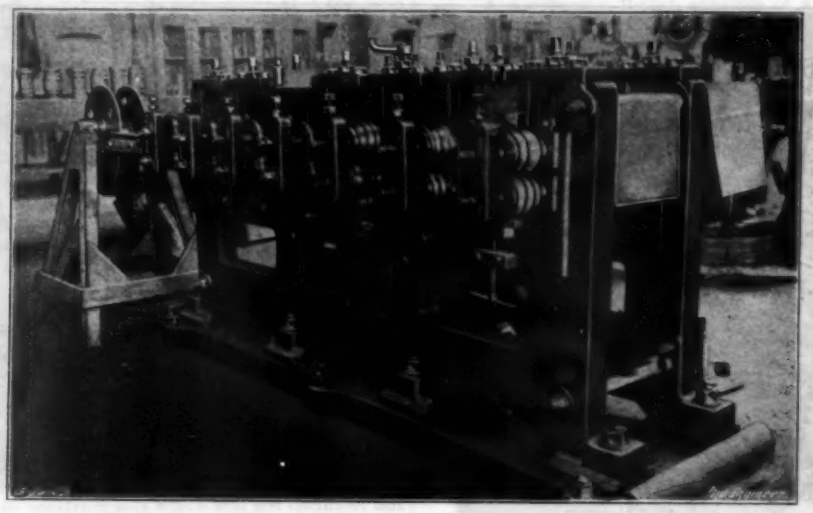


MACHINE FOR DRAWING SECTIONS FOR AEROPLANE CONSTRUCTION

In the illustration on page 460 of our issue of October 20 we showed a machine for drawing sections for aeroplane construction. It may be remarked that the power plant consists of two Napier 450 horse-power "Lion" engines, and that the machine carries a pilot and two gunners. It has a wing span of about 60ft., an overall length of about 48ft., and weighs, fully loaded and ready for flight, in the neighbourhood of 5 tons. It was designed by Mr. J. D. North, the company's chief aeronautical engineer, and was recently successfully flown for the first time by Mr. F. T. Courtney, the firm's test pilot. More than this we are not at liberty to say with reference to this particular machine, but we are not restricted by the requirements of the Services from dealing with certain general aspects of Boulton and Paul's system of metal construction.

which are not called upon to take any structure stresses, and which can therefore be made from ordinary carbon steel.

The flat strip is formed to the required section either by passing it between successive pairs of rolls or by pulling it through a series of dies in a drawing machine. The rolling process is the cheaper both with respect to the first cost for the tools and with respect to the charges for labour attendance. The process is, however, limited in application to a comparatively small number of the sectional forms required, for, of course, it is impossible to produce by pure rolling any section which involves bending the strip upon itself through more than 180 deg. In



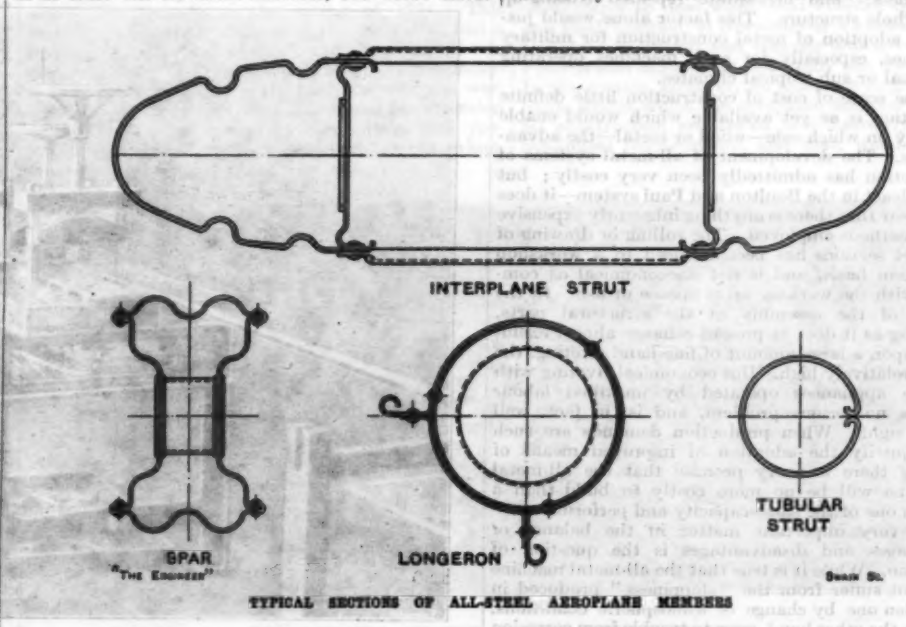
MACHINE FOR ROLLING SECTIONS FOR AEROPLANE CONSTRUCTION

actual fact, even a semi-circular section or a square-angled channel section cannot be rolled in the material employed, for the spring back of the metal after rolling results in the finished section in all cases being different from that of the daylight between the rolls. As an indication of the results obtained it may be said that if the rolls are formed to show the section of a right-angled channel, the material after rolling will have a section of which the corner angles, instead of being 90 deg., will be about 120 deg.

The alternative to rolling is drawing, but it is considerably more expensive, both in the matter of the dies and of the labour charges. Whereas in the rolling machine the strip passes in succession between anything up to seven pairs of rolls, in the drawing machine not more than two stages of the total process can conveniently be made at one pass. The production of the dies, too, is a matter involving considerable expense, for naturally they have to be very carefully made in order to withstand the considerably greater wearing action than that to which the rolls of the rolling machine are subjected. Moreover, the exact form to give them is difficult to determine. Not only has the spring back of the metal to be allowed for, as in the case of the rolls—although to a lesser degree—but the form and the pressure applied to the dies have to be regulated with due consideration for a troublesome phenomenon which is found to occur in the production of certain sections. When drawing a U-shaped or semi-circular or similar section it is found that the edges will sometimes corrugate into a series of more or less equal-sized waves as a result of elastic instability or the failure of the metal to withstand the local stresses produced in it during the drawing process. The development of these corrugations is found to be influenced by the form of the dies and the pressure applied to them, and can be avoided by suitably modifying—perhaps to quite a small degree—the conditions imposed upon the metal by these two factors. A similar trouble, though not so marked, occurs sometimes in the rolling process. On the other hand, the rolling process may give rise to cracking in the metal. Both these defects have been closely investigated, and sufficient experience has now been accumulated to enable them to be overcome quickly should they develop.

It will thus be seen that the formation of the steel strip material into the required sections is almost as difficult a problem as that of determining what, from the aero-structural point of view, those sections should be. The exact manner in which to form a given section permits of many possible variations, and it is not always obvious which is the best and most economical to adopt. Some of the sections call for drawing in two or more passes, and others for rolling, while yet others may best be handled by a judicious combination of rolling and drawing. For the success of the processes of forming the sections it is obviously essential that the material employed should from batch to batch have fairly uniform elastic properties, for otherwise the spring back of the metal would result in a given set of dies or rolls producing somewhat different sectional forms with different classes of metal. The limits permissible for variation in the thickness, flatness and straightness of the metal strip are also rather narrowly prescribed. These facts would suggest that from the manufacturing point of view metal construction exacts a much greater attention to and control over the properties of the raw material than does wood, and to that extent suffers disadvantage in the comparison. On the other hand, while spruce is spruce and will remain spruce for all time, the whole field of possible metallurgical development is behind the metal aeroplane, and in that respect there is a hopefulness about its future which is quite absent in the case of the wooden aeroplane.

One possible criticism of the use of steel or other metal for aircraft construction is the suggestion that it throws the door open to failure of the structure by fatigue. The fact is, however, that aircraft do not afford a fruitful ground for the development of violent stress fluctuations except in one respect, namely, in the "rafwires," the streamline sectional stay wires between the wings, &c. These wires are so placed that they are aerodynamically unstable and are therefore subjected to forced vibration when the machine is in flight. The singing noise coming from an aeroplane when it is gliding with the engines shut off is produced by the vibration of the rafwires. In flight, under power, however, it is almost completely drowned by the noise of the engine and propeller. In this connection it is noteworthy that many pilots dislike rafwires because of their lack of "give," and in at least one all-metal machine, the Short Silver Streak, stranded cable is used in preference to them.



TYPICAL SECTIONS OF ALL-STEEL AEROPLANE MEMBERS

A noticeable feature of certain all-metal aeroplanes previously constructed, such as the Short, the Junkers and the Zeppelin Staaken, has been the use of sheet metal—aluminium or duralumin—covering for the wings and fuselage. In the Boulton and Paul system the usual fabric is adopted for this purpose. Mr. North, the company's chief aeronautical engineer, does not regard the employment of metal covering as up-to-date practice. The wing covering of the Short machine is believed to weigh 0.2 lb. per square foot. As compared with fabric this figure represents an increase of 5 to 6 per cent. in the gross weight of the machine, and therefore notably diminishes its useful load-carrying capacity. It is not, however, solely in connection with increase of structural weight that objection is found to the use of a metal covering. Almost as important is the consideration that the sheet metal is much more troublesome to remove and re-apply than fabric covering when—as is customary once in about every twelve months—the wings are stripped for examination of their internal structure.

We are not at liberty to describe the detailed construction of the Boulton and Paul all-metal "Bolton" biplane illustrated herewith, but as some indication of the constructional features associated with the firm's system in general we give a drawing of four typical sections of certain members. The first sketch shows a section evolved for the interplane struts. It consists of two approximately Δ-shaped portions united by channel-sectioned lattice members, the whole after assembly being faired with a fabric covering. The V portion of each Δ section is rolled and drawn to the required form. The remaining portion is drawn and thereafter lightened and stiffened by forming a series of large flanged holes along its centre line. The spar section is built up of four corrugated strips, the webs being united and stiffened by means of tubular distance pieces. These distance pieces are made of thin solid drawn carbon steel tubing cut to length and staved up in the cold on a mandrel to form the flanges. After assembly the mouths of the distance pieces are beaded over by means of a spinning tool in a drill press. The longeron section consists of one piece forming three-quarters of a circle with the edges rolled and turned outwards and a quarter circle piece filling the gap. The three-quarter piece is stiffened internally by a number of flanged rings, and is by itself designed to be sufficiently strong to accommodate the whole of the bending moment to which the part is subjected. The quarter piece is inserted for the purpose of increasing the resistance of the member to secondary torsional stresses, and is cut away at the points at which the interlongeron struts are attached. At such points an ⊤-shaped bracket is inserted, with its limbs riveted to the turned-out edges of the three-quarter piece, for the purpose of providing the attachment for the struts and diagonal stays. The interlongeron struts, as shown in the fourth sketch, are circular in section, and are formed from a strip with rolled edges. It is, we understand, difficult to obtain solid drawn nickel chrome steel tubes of the light gauge required. Otherwise no doubt they would be adopted in preference for the close-jointed section illustrated, although this form possesses a slight advantage in the fact that the beaded edges offer increased resistance to local deformation in their neighbourhood. The struts after formation are hooped with steel rings at intervals of about 10–12in., and are united to the longeron brackets by means of sockets sweated to their ends. These sockets are in some instances machined from the solid. In others they are built up from tubing and plate. Throughout all the sections the rivets are of ordinary steel, although stainless iron will be used exclusively at a later date. The holes for the rivets are punched where possible. In the larger sizes they are drilled, for at present there is a certain amount of difficulty experienced in punching the material.

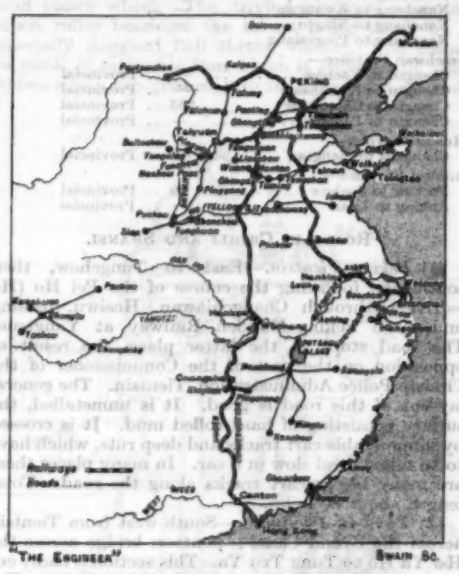
THE nearly four millions wanted by the Underground people for the London Electric Railways, Central London, and City and South London were over-subscribed. One purpose to which this money will be devoted is the extension of the Great Northern, Piccadilly and Brompton Railway at Hammersmith to the London and South-Western Railway Company's branch from Addison-road at a point east of Ravenscourt Park Station. Powers for this work were obtained in 1913, and mention was made of the work in this column on September 8th last.

China's Roads.

To those who lived in China ten or twenty years ago the idea of writing about roads in that land will seem almost ridiculous, for there was then nothing worthy of the name throughout the country, while there seemed little prospect of substantial highways being built for years to come. Within comparatively recent times, however, especially since the great famine, some important roadmaking schemes have been formulated, some of them put in hand, and regular services of motor cars have been organised to provide communication between towns and cities. The wide field which this policy covers is indicated in the sketch map which we publish. On it there are shown most of the principal highways projected, in course of construction or finished, while the main railways and the three big rivers are included.

It is, of course, to the construction of more railways that European engineers look as a means of developing the resources of China and finding an outlet for their manufactures. Unfortunately, railway building is practically at a standstill just now, and is not likely to be proceeded with until the political situation of the country becomes more stable. In the interval, however, roadmaking is progressing fairly rapidly, largely on account of the opportunities which it offers of giving employment to people left destitute by the famine and who are more or less maintained by foreign philanthropy. Many of these roads will undoubtedly form important links in the means of communication and as feeders for the railways and rivers; and while, under the present *régime*, one of the chief considerations of the promoters is to employ as much labour as possible, it seems probable that the movement may ultimately lead to the adoption of modern mechanical appliances for assisting labour.

The hopes of the promoters are supported by the experience of reformers in other somewhat similar directions. Thus on the West River some important reclamation schemes have been undertaken and, although there was some difficulty at first in getting the funds necessary to carry them out, the works have resulted in such an increase of local prosperity that the policy is being extended rapidly and the landowners are becoming quite willing to finance the business. But reclamation work is a class of engineering with which the Chinese have been familiar for centuries, whilst roadmaking, in the European sense, has been entirely neglected. That is to say, of course, outside the settlements and concessions, where there are many first-class roads. In the native cities there are narrow streets, of which the pavement comprises great stones, as shown in one of our pictures, that also serve as the cover of the drains beneath and which have to be lifted periodically for clearing out the sediment; but outside the cities there are the merest tracks indicating the route from one place to another. Along these tracks the traffic finds its way as best it can in the circumstances.



MAP SHOWING CHINA'S PROJECTED ROADS

In the North the two-wheeled cart is the principal conveyance, and to it is hitched any animal, or animals, that may be available. The "going" is so heavy, either on account of the mud or the dust, that anything with four legs is impressed for drawing the carts, and it is no uncommon sight to see a mixture of, for instance, an ox, a camel, a few ponies and donkeys, and even the womenfolk tugging at a single cart. And, in view of the fact that no attempt is made to prepare the surface of the earth for the traffic, it is really surprising that the carts are kept going at all. Some of the engravings which we reproduce from photographs taken recently show how the drivers wander all across the track in an endeavour to find an easy path, while another gives some idea of the obstructions which have to be surmounted in the more hilly districts. The cart was actually in motion, going over the boulder shown in the picture, when the photograph was taken. Stones, such as these, strew the tracks, and no systematic effort is made to clear them away.

The natural conditions in the northern part of China, in Shansi and the other provinces bordering on the great bend of the Yellow River, are very arduous for the road engineers, and account to a large extent for the primitive state of affairs. Away from the hills the country comprises great stretches of loess, a soft neutral-tinted earth, which, although it will stand with a perpendicular face of considerable height when it is dry, disintegrates very rapidly when wet. Two of the views on page 470 show the effect of this peculiarity of the soil very forcibly, where temples, originally built on the normal ground level, now stand on tall pinnacles on account of the surrounding soil having been eroded away. Such material as this cannot be classed as good for roadmaking, but there is little else to be found for stretches of hundreds of miles, and road metal must be brought from distant quarries.

Added to the difficulty of finding suitable materials, the road engineer is faced with the problem of combating floods that annually spread over miles of the countryside, and also with providing a surface that will withstand the punishing effect of the native traffic. Besides the Peking cart, with its menagerie of draught animals, there is the wheelbarrow of the North. This barrow has a wheel about a yard in diameter, shod with an iron tire not more than 1¼in. wide. The load is balanced on either side of this wheel and may amount to some 5 cwt., or, say, half-a-dozen passengers. The handles are spaced very widely apart and a band fixed to the handles passes over the shoulders of the coolie to help him in steadying the load. Sometimes another coolie pulls on a rope in front, as shown in one of our pictures. Large numbers of these barrows are employed, and they always follow closely in one another's tracks. The result is that the narrow tires cut deep grooves in the road. Even the granite-paved roads of the settlements cannot stand up to the wear and tear, and a narrow and dangerously deep groove is worn in the stones near the gutter.

PEKING CART ON A ROUGH ROAD

NATIVE STONE ROLLERS

COOLIES WITH ROLLER

ROAD IN MOUNTAINS

STREET IN NATIVE CITY

ROAD THROUGH SHANSI MOUNTAINS

The seriousness of the ruts which are formed in the earth roads, by the combined effects of traffic and weather, may be judged from the fact that for a motor car to negotiate them the back wheels have to be allowed to slide gently into the depression and the low gear must then be used for climbing out again on the other side.

In the more southern part of the country this trouble with wheel ruts is not encountered, for the simple reason that there is no wheeled traffic. The tracks will not bear a wheeled vehicle, while there are very few, if any, draught animals. Merchandise is carried on poles by coolies and passengers are conveyed in sedan chairs. The coolies bear loads of about 100 lb., or, if they are carrying on their own account, often twice as much, and pick the best way they can across the country. The constant traffic—and it is very heavy—beats out a hard path in the soft soil; but unless it is above flood level the track is obliterated annually and must be trampled out again when the mud dries.

It will be readily appreciated, in view of the above notes, that the problem of providing China with good roads is not only a difficult one, but also one of great magnitude. Already quite a number of so-called roads have been made in various parts of the country, but it is very difficult to get authentic information concerning the schemes taken as a whole, and there is no doubt that many of the roads which are reported to have been completed have only rolled earth surfaces. The metalling of these roads is being postponed until funds are more easily obtainable.

We give illustrations of some typical native rollers used in roadmaking. Some of these rollers are solid cylinders of limestone, 3ft. or 4ft. in diameter by about 5ft. long, and are drawn by gangs of from twenty to forty coolies according to their weight.

In the extreme south there is one instance where more modern methods of road building have been adopted. In the native city of Canton some fine boulevards have been constructed largely under American supervision. The city walls were pulled down to make room for the new roads, and it is noteworthy that native contractors competed eagerly for the work on condition that they might keep what they found. It has always been believed that considerable treasure had been buried in the wall, and it is said that several contractors made fortunes by their finds.

The list which we give below has been compiled largely from notes issued by the Chinese Government Bureau of Economic Information; but in the cases of the roads marked with an asterisk the additional particulars given at the end come first hand from an engineer who has recently traversed the country. All these roads are indicated on our map.

Finished and Projected Roads in China.

From	Miles.	Builder.
Chihli Province—		
Tsangchow to Shihkiachwang	139	Ministry of Communications
*Tientsin to Paoting	75	Amer. Red Cross
*Taming to Hantan	46	Amer. Red Cross
Kalgan to Dolonor	219	Ministry of Communications
*Peking to Tientsin	72	Amer. Red Cross and Government
Shangtung Province—		
Chefoo to Weihsien	180	Government
Tsaochwang to Ichow	150	Provincial
Chefoo to Weihaiwei	—	—
Shansi Province—		
*Tatung to Taiyuan	—	—
*Taiyuan to Pingyan	—	—
*Pingyao to Fenchow	—	—
*Yangchuan to Liaochow	—	—
Shenchow to Sian (Shensi)	156	Provincial
Shensi Province—		
Tungkwan to Shenchow (Honan)	45	Private
Kiangsu Province—		
Shanghai to Woosung	—	Provincial
Soochow to Huchow	245	Private
Chekiang Province—		
Huchow to Kwangteh	—	—
Hangchow to Shanghai	—	Private and Provincial
Kiangsi Province—		
Nanchang to Kanchow	275	Provincial
Nanchang to Kwangsin	—	—
Nanchang to Ningtu	—	—
Nanchang to Pinghsiang	—	—
Szechwan Province—		
Chengtu to Yachow	—	Provincial
Chengtu to Kwanhsien	—	Provincial
Chengtu to Chungking	265	Provincial
Chengtu to Pachow	—	Provincial
Hunan Province—		
Changsha to Siangtan	—	Provincial
Anhwei Province—		
Pochow to Suchow	90	Provincial
Anking to Luan	—	Provincial

Roads in Chihli and Shansi.

(1) *Peking–Tientsin.*—East to Tungchow, then south-east, following the course of the Pei Ho (Ho = river), through Changchiawan, Hosiwu, passing under the Peking–Mukden Railway at Yangtsun. The road stops at the latter place, the result of opposition on the part of the Commissioner of the Chinese Police Administration, Tientsin. The general lay-out of this road is good. It is unmetalled, the surface consisting of hard rolled mud. It is crossed by innumerable cart tracks and deep ruts, which have to be taken dead slow in a car. In many places there are many heavy cart tracks along the road. Total length about 90 miles.

(2) *Tientsin–Paotingfu.*—South-west from Tientsin across the Grand Canal; pontoon bridge across the Hsi Ya Ho to Tung Tzu Ya. This section is badly cut by cart tracks. Then west to Ta Cheng Hsien. The above section, 50 miles in length, is in fairly good condition, as a separate cart track is provided. The road now runs due west to Jen Chin, a further 30 miles. This section is badly cut, as a separate cart track is not provided. The next section to Kao Yang, some 25 miles, is also impassable. It runs through sandy soil and in places the course is almost lost. The final section to Paotingfu, 30 miles, is in better condition, and two motor omnibuses are running to Kao Yang, the single fare being 1 dollar Mex.

(3) *Tamingfu, Han-Tan, Wuan.*—This road runs north-west from Tamingfu across the Shih Ho to Hantan on the Peking–Hankow Railway, and thence to Wuan, situated in Shansi. The Hantan–Wuan section is metalled and cars run daily between these places. It is the intention of the authorities to continue the road in a north-easterly direction from Tamingfu, across the Grand Canal at Tungchangfu, to Tsinanfu.

(4) *Tatungfu to Taiyuanfu.*—(See page 470.) The route from north to south is as follows:—Hwaijen, Kiotai, across the Sang Kan Ho, Kuan Wu Kow, cutting a branch of the Great Wall at the entrance to the pass, Yen Men Pass, Kuo Hsien, following the course of the Huto Ho, through Yüan Ping to Sinchow Hsia, Shigling Pass, Chengtsin to Taiyuanfu. Tatungfu and Taiyuanfu are 4700ft. and 3000ft. above sea level respectively. The sections from Kuo Hsien to Taiyuan and from Tatungfu to the pass are not metalled. For these sections metalling will have to be transported for considerable distances. A branch road runs from Sinchow to Wutai.

(5) *Yang Chuan.*—On the Cheng-tai Railway, south to Shuofang-tsun, Lopinghsiang, Ho Shun to Liaochow. The total distance is about 80 miles. Road metalled; rollers native made.

(6) From the Yellow River east to Yung-ningchow, then south-east to Fenchowfu (metalled,), thence to Ping Yao Hsien. The latter section has a surface of ashes only.

(7) *Taiyuan.*—South-east following the railway to Yü-tzu, then south-east to Sukow, and to Taiyuan, Sukow, Tai Ku Hsien, Chih Hsien, Pingyachsien (see illustration). This road is planned to go through the Hanhow Pass, Huochow, Pingyangfu, Howma and Wensi to Puchowfu, in the extreme south-west corner of the province. No attempt has been made to metal the completed sections immediately south of Taiyuanfu. Intermediate sections of the road south of Huochow are now being made.

(8) *Fenchow.*—North-east to Wenshia, and north-east to Taiyuanfu. This road is partly metalled, but not rolled.

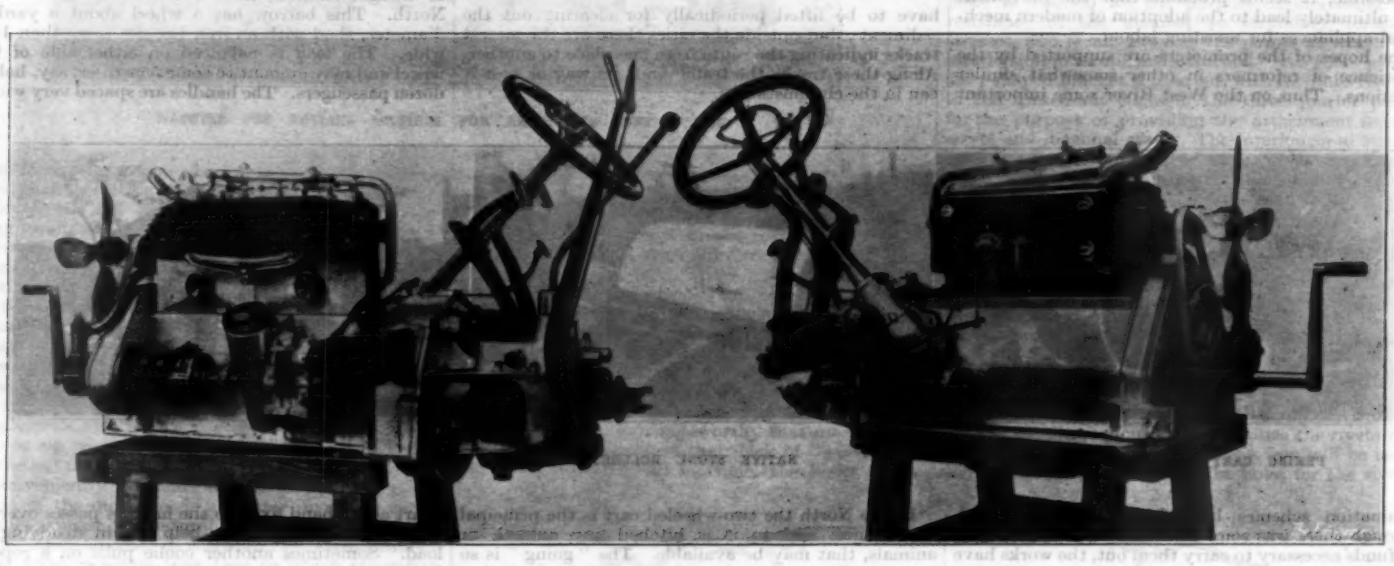


FIG. 1—POWER UNIT OF RUSTON AND HORNSBY CAR

The Motor Car Shows.

No. I.

The annual exhibitions of motor vehicles and accessories, which are held under the auspices of the Society of Motor Manufacturers and Traders, open to-day at Olympia and the White City. Although new and epoch-making features will be conspicuous by their absence, it is generally anticipated that the 1922 exhibition will demonstrate the advanced state of development which has been reached in automobile engineering. It was recently pointed out by Lieut.-Colonel D. J. Smith in his presidential address to the Institution of Automobile Engineers how the present system of taxation of motor vehicles has influenced the designers. In order to keep down the annual tax payable the makers have had to restrict to the smallest possible limit the diameter of the cylinders. The outcome of this method of taxation has been the production of engines of the smallest possible dimensions operating at the highest possible efficiency. Originality in design is thus crippled. It is hoped that in the not far distant future a system of taxation based upon the amount of use which individual motor owners make of the roads will replace the present inequable method and thus give free scope to designers with original ideas. At the present time by far the largest contribution to the Road Fund is made by private owners, while the heavy commercial vehicles, which are undoubtedly responsible for the greatest amount of wear of the road surfaces, escape comparatively lightly.

Specifications of over 300 cars on the British market recently compiled show that for next year's passenger vehicles four-cylinder engines, with side-by-side valves, detachable heads, thermo-syphon cooling and magneto ignition are most generally favoured, while cone clutches, four-speed gear-boxes and spiral bevel final drives form the most popular type of transmission. The overhead-valve engine has increased somewhat in favour since last year, but is still a long way behind the side-by-side mushroom type as regards popularity. Many of the firms which have hitherto confined their attentions to the higher-powered and more expensive cars now see the necessity for providing the less costly machines which require little or no attention and can be driven by the owner. In this category there will be available next year one or two makes of cars with six-cylinder engines. We shall have more to say concerning the trend of design after an inspection of the exhibits.

Ruston and Hornsby.

The firm of Ruston and Hornsby, Limited, show two new types of car, namely, of 16 horse-power and 20 horse-power. The chassis of these cars are of the semi-unit type of construction in which the engine, clutch and gear-box are built up together, but each unit is separate as far as the lubrication is concerned. In Fig. 3 on the succeeding page we show a general view of the 16 horse-power all seasons model, and in Figs. 1 and 2 illustrate the 20 horse-power engine unit, which resembles in its general features the 16 horse-power engine unit. The 20

horse-power engine has four cylinders 90 mm. bore by 130 mm. stroke, develops 25 horse-power at 1000 revolutions per minute, and has a maximum output of 50 horse-power. The unit is of four-point suspension. Two feet which are relatively close together at the forward end of the engine are supported by a cross member, while at the rear end support is provided at the fly-wheel housing to which are bolted detachable feet, which in turn are supported in the frame side members. These feet are of cylindrical section, and serve to carry the steering box and controls, as well as the foot operated control levers for the accelerator, clutch or foot brake. This arrangement permits of right or left-handed control without any complication other than the change over of either of the feet. Power is transmitted from the gear-box through an open propeller shaft, with universal joints at both ends, to a rear axle of the Hotchkiss type in which all wheel reaction is taken through the front half of the rear spring. In order to decrease the amount of wear on the universal joints the unit lies at an angle to the top of the frame, so that when the car is loaded there is very little movement at these joints.

The valves are of large diameter, and are made from fine alloy steel, and are operated by adjustable tappets fitted with case-hardened and ground rollers. These tappets work in hardened and ground guides which are detachable for replacement. All the valve gear is enclosed. The lubrication is effected by a gear pump driven by skew gear. The pump unit is detachable and is withdrawn from the top of the crank case. This unit—see Fig. 2—is built up of a filler, pressure filter and pump, so that on withdrawal the whole of the lubricating system, with the exception of the pipes, can be inspected and cleaned conveniently, without disturbing any other part of the engine. The pressure filter is so arranged that if it is improperly replaced the resultant oil leak will return to the crank case and thus prevent mechanical damage through lack of oil. The bearings of the crank shaft, cam shaft and connecting-rod big ends and timing wheels, thrust bearings of the crank and cam shaft, are all positively lubricated by pressure, the oil being distributed by steel pipes cast in the crank case.

The engine is cooled by means of a honeycomb radiator and centrifugal pump, assisted by a fan mounted upon ball bearings and driven by belt. The centrifugal water pump is bearingless, the impeller being mounted upon an extension of the dynamo spindle. The clutch is of the direct cone type faced with fabric. The spring pressure for it is supplied by four small springs of small diameter centrally placed lever which operates the gears through a concealed gate. All ball bearings used in the gear-box are mounted in steel housings and not direct into the aluminium casing. The final drive has a reduction of 4 to 1 through spiral bevel pinion and crown wheel. The driving pinion is mounted upon roller bearings, the thrust being taken by a specially designed ball thrust washer. The casing is made of malleable iron which is stiffened by steel tubes which are pressed into it. The hand controls

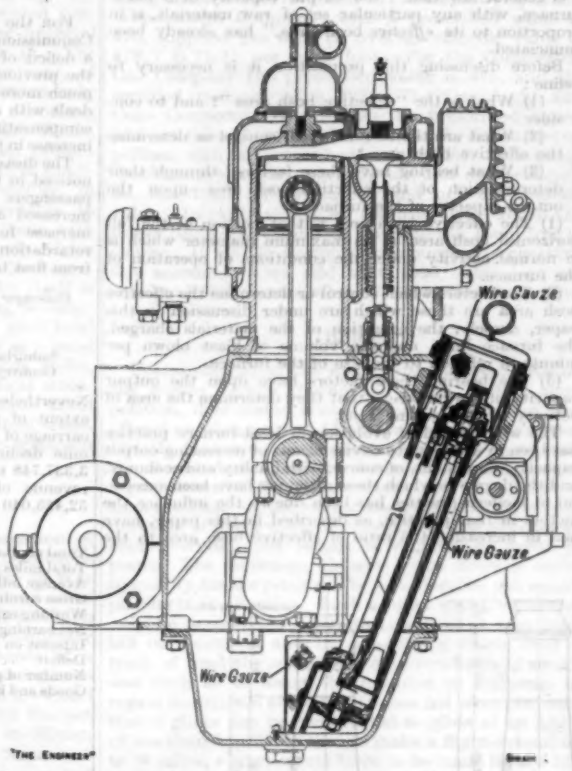


FIG. 2—SECTION THROUGH RUSTON-HORNSBY ENGINE

are placed at the top of the steering column concentric with the wheel, and operate through tubes passing through the steering column, and at their lower ends operating through cams and cam followers of hardened steel. This device adds very considerably to under-bonnet neatness. A foot accelerator is also provided.

The electrical equipment is of Brolt or C.A.V. manufacture for 12 volts. Both dynamo and starter are positively fixed to the crank case, and the dynamo is driven by helical gears. The magneto takes its

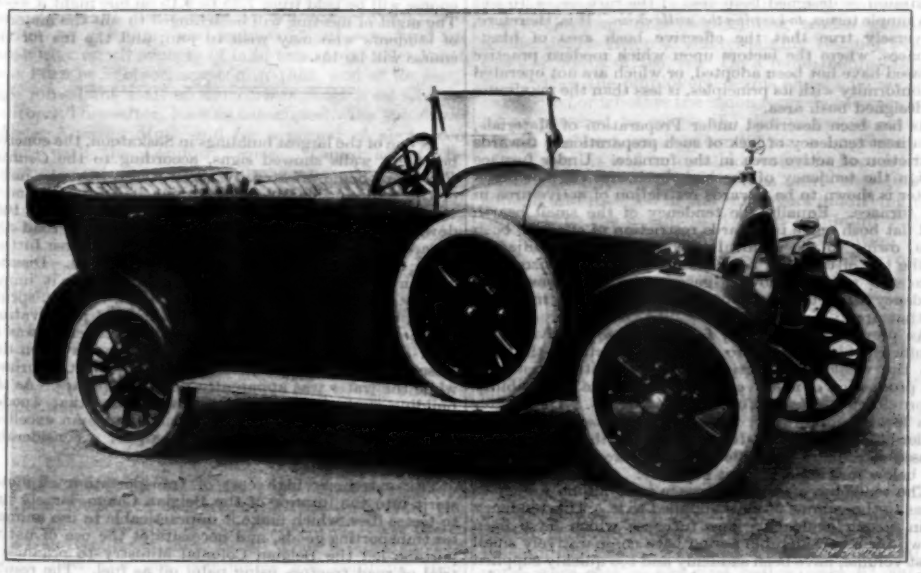


FIG. 3—RUSTON-HORNSBY 16 HORSE-POWER CAR

around its periphery. A detachable clutch stop is provided.

The gear-box and transmission is of the three-speed and reverse type, giving as ratios:—Reverse, 3.88/1; low, 3.02/1; intermediate, 1.633/1; top, 1/1. The gears are made from alloy steel oil toughened, and the shafts are mounted in ball bearings. The only plain bearings used are for the main shaft spigot, which is of very large diameter, and for the reverse idle wheels. Gear change is actuated through a drive from the dynamo rear end. The pinion engagement is of the Bendix type. The wheel base of this car measures 10ft. 6in., and the track 4ft. 8in. The springs both in the front and in the rear are of the semi-elliptic pattern, very long and flexible, the rear spring being underslung. Lubrication of the chassis parts is effected by means of a grease gun and flexible connection to nipples throughout the chassis.

The Bases of Modern Blast-Furnace Practice.*

By A. K. REESE.

(*Continued from page 407.*)

II. FURNACE DESIGN.

In the sense in which this heading bears upon the purpose of this paper it refers not to the structural detail of the furnace as a whole, but to that portion only in which the metallurgical operations take place; that is, the furnace proper, the interior space, the design of which is technically known as the "lines of the furnace."

The terms usually used to describe the lines of a blast-furnace divide it into a number of sections, namely, the hearth or crucible, which is cylindrical; the bosh, an inverted truncated cone; the shaft, an upright truncated cone; and the throat—in modern furnaces usually cylindrical—extending from the top of the shaft to the top of the furnace.

The principal dimensions of these sections consist of heights, diameters, the acute angle of the bosh wall to the horizontal, and the batter of the shaft wall to the vertical. Each of these dimensions has a very important bearing upon all the others, and their relation to each other is of the first importance as a factor in modern blast-furnace practice; for although they may vary somewhat in their relation, the variations are limited to conform to certain principles, the height of the furnace and hearth diameter being the dimensions which control all the others.

Under this heading—Furnace Design—the author proposes to outline and discuss these principles, and to enunciate as a general law the principle that *the output capacity of a blast-furnace (with any particular set of raw materials) is in proportion to the effective bosh area.* The nucleus of this law is the word *effective*, for, as will be later shown, the maximum effective bosh area is dependent upon the various factors which constitute the principles of modern blast-furnace practice.

Modern development in blast-furnace design has established the following essentials. A shaft batter of 1 in 13.5 to 15, the low bosh, the large hearth diameter, and the steep bosh angle—all of which are, of course, comparative terms in their relation to similar features in the older designs.

The Fig. shows two furnaces, "A" and "B" of pre-modern lines—extreme cases have been chosen in order to emphasise the principles under discussion—and two furnaces, "C" and "D" of modern lines—the tendency is further to increase the hearth diameter, and a furnace is now in successful operation with a hearth diameter of 20ft. 9in., but in this direction it is sufficient for the present purpose to avoid the extremes.

Throat and Stack.—The upper section of the furnace or throat is, as above mentioned, usually cylindrical in shape and extends to from 20ft. to 25ft. below the furnace top or 12ft. to 17ft. below the stock line, the highest point to which the furnace may be filled. The adoption of the cylindrical throat is primarily in order to obtain the desired batter to the shaft walls, although it also has a bearing upon regularity of distribution by presenting to the charged materials an area of the same dimensions for the varying positions of the materials in the throat due to their constant movement. The latter point, however, is not of great importance in the modern furnace plant as the charging appliances are usually, or should be, of ample capacity to keep the furnace fully charged at the highest rate of driving.

Within the distance to which the cylindrical throat extends the condition of the materials is such that there is no tendency for them to adhere to the walls or to hang through jamming, or arching, as they are in a "dry" condition, both as to moisture and pastiness, and their expansion through increase in temperature is not yet sufficient to require increased space for their accommodation so as to avoid the danger of restricting free movement. Below this point, however, temperature increase becomes much more rapid and reactions much more intense. In this alteration in condition and temperature, which is progressive as the materials descend, more space accommodation is required for free movement, more particularly because to expansion is added the semi-pasty and pasty condition, and the increased density of the mass through the increasing load bearing down upon it from the increasing weight of superimposed materials. It is also probable that the question of carbon deposition enters into the necessity for greater space accommodation as the materials descend into the hotter and more active regions of the furnace. Hence the necessity for the expanding batter to the shaft walls. It would also seem obvious that the more rapid the descent of the materials into and through these zones—faster driving—the greater must be the increase in space accommodation. In the older furnace designs, with slower driving, shaft batters as low as 1 in 26, and possibly less, were in use. In modern practice it has been found necessary to increase this batter to 1 in 14, or thereabouts. The principles involved in this feature of modern blast-furnace design are of the greatest importance, and probably explain, in part at least, why many furnace managers have failed in their attempts to apply fast driving to furnaces with lower shaft batter.

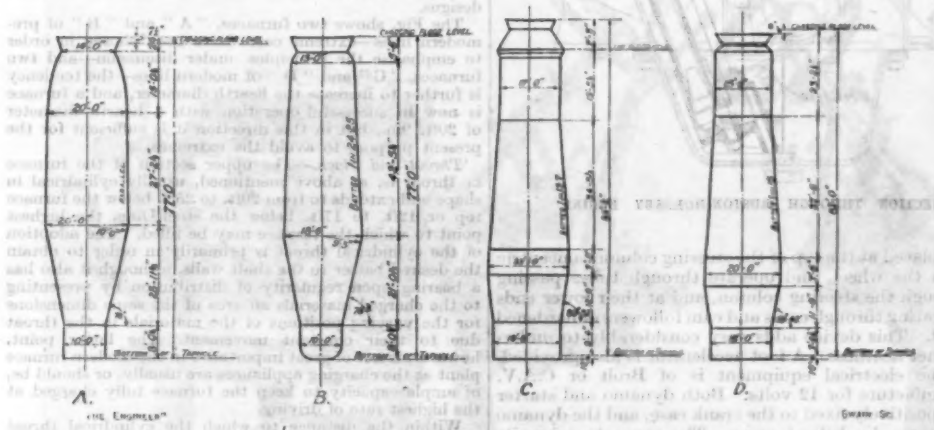
To revert for a moment to throat diameter, there are in this feature several opposing conditions to consider. The lower the velocity of the gases as they leave the furnace top, the lower the loss from flue dust carried over with them. The largest possible throat diameter is, therefore, desirable for this reason. On the other hand, the extent to which this feature may be provided for is limited by the question of distribution, both of the materials charged into the top and the ascending gases, as regards the most uniform action of the latter over the whole cross-section of the former. The throat diameter is also limited by the required shaft batter, and the bosh diameter and height. Sacrifices must, therefore, be made in one direction or the other, and as the question of losses by flue dust is largely affected by regularity of stock movement, features tending to the latter should have first consideration. Throat diameters are, therefore, restricted in modern furnaces of 85ft. to 95ft. in height

* Iron and Steel Institute. York Meeting, 1922.

to from 15ft. to 17ft., the controlling factors being the other dimensions such as hearth diameter, bosh diameter, and height.

The Low Bosh.—The low bosh was the direct outcome of attempts to increase blast-furnace outputs by increasing the volume of blast blown per minute. These attempts with the old high bosh furnaces resulted in seriously increased furnace irregularities, the reason for which became apparent from the study of the altered conditions brought about in the furnace through the more rapid driving, and the troubles experienced. With the much more rapidly descending materials it was found necessary that the contracting part of the furnace, that is, the top of the bosh, should begin below the upper limit of the zone of fusion in order to prevent the pasty materials just above the zone of fusion entering the contracting area, where they would be subjected to a squeezing action as a result of the resistance of the bosh walls, and the weight of the superimposed materials, with the consequent tendency to pack and cause hanging and the formation of scaffolds on the upper bosh walls.

The continued lowering of the top of the bosh followed therefore the continued attempts at faster rates of driving for larger outputs, until in modern practice a bosh height for 85ft. to 95ft. furnaces, of 10ft. to 12ft. above the top of the crucible, has been adopted as compared with as much as 30ft. in the old design. Whilst it is true that no one would build a furnace with a 30ft. high bosh to-day, there are furnaces in operation of recent design with boshes 16ft. to 18ft. or even higher. Any attempt to rapidly drive such furnaces is sure to result in increased irregularity and consequent failure. The basis of this principle—the low bosh—is, therefore, that the furnace must be so designed, as regards bosh height, that the expanding portion of the furnace, that is, the shaft, shall continue to a point slightly below the beginning of the melting zone, so that no pasty materials shall enter the contracting portion at the top of the bosh. In actual practice many, in fact most, modern furnaces are designed with a cylindrical section from 5ft. to 8ft. in height between the lower limit of the expanding shaft and the upper limit of the contracting bosh. This section has no justification from the standpoint of any principles involved in its adoption, except that it fills up with brickwork the angular space at the junction of the bosh and shaft,



BLAST FURNACE DEVELOPMENT

which to a degree may be considered "dead space," and renders less abrupt the transition from the expanding shaft to the contracting bosh, but is rather the result of necessity in order to obtain the desired relation between other features such as shaft batter, throat diameter, and bosh diameter and height.

The bosh diameters, for what may be called full-sized blast-furnaces, that is from 85ft. to 95ft. high, are usually from 20ft. to 23ft. with a bosh angle of about 80 deg., while in pre-modern designs this angle was anything from 68 deg. or less to 74 deg. The latter feature is the result of the progressive increase in hearth diameters, and, as the author will endeavour to show further on, these two features, the steep bosh angle and the large hearth, are concomitant, and their evolution the result of efforts to overcome irregularities through the failure of earlier designs—with the flatter bosh and smaller hearth diameter—to bring into operation the maximum effective bosh area, which is, of course, the full bosh area.

The Hearth or Crucible.—In the modern full-sized furnaces hearth diameters are normally from 16ft. to 18ft., although, as has already been mentioned, in one instance this dimension has reached 20ft. 9in. At present, however, the latter may be taken as an extreme, and it remains to be seen whether hearths of this size are likely to be generally adopted. In the process of evolutionary experiment it is often necessary to overreach the maximum in order to ascertain what it really is.

The hearth diameter of a blast-furnace would seem, at first sight, to be the determining factor for its output capacity, and, in the sense that it is the starting point in the design, and, with the bosh angle and bosh height now generally adopted in modern design, practically determines the bosh diameter, it is so, but in the sense that the hearth diameter, together with the low bosh and steep bosh angle, are merely means for making effective the maximum bosh area it is not really the determining factor, which is the bosh diameter. The hearth, or more properly the crucible, is the receptacle for receiving and storing from cast to cast the molten materials, while the bosh area is the active area in which the molten materials are produced as such, and the proportion of that area which is in active operation is the determining factor as to the quantity of molten materials available for collection in the crucible.

In all previous references to the various dimensions of the modern blast-furnace, and the principles which have led to their adoption, it is, of course, assumed that in the operation of the furnace the volume of blast is in keeping with the size of the furnace, and is such as will provide the operating conditions upon which those principles are based. In modern practice the volume of blast blown is normally from 40,000 to 50,000 cubic feet of free air per minute delivered from engines capable of delivering these volumes against pressures, or rather resistances, up to 25 lb. or 30 lb. per square inch, to provide ample reserve power for conditions causing abnormally high pressures. Normal working pressures are usually between 15 lb. and 20 lb.

Effective Bosh Area.—This term, used several times in the foregoing is, the author believes, a new one in blast-furnace nomenclature, but it is one which has a meaning of the first importance in blast-furnace operations.

A general law that "the output capacity of a blast-furnace, with any particular set of raw materials, is in proportion to its *effective* bosh area," has already been enunciated.

Before discussing this proposition it is necessary to define:

(1) What is the "effective bosh area"? and to consider

(2) What are the factors which control or determine the effective bosh area?

(3) What bearing have these factors—through their determination of the effective bosh area—upon the output capacity of the furnace?

(1) The effective bosh area is that portion of the full horizontal bosh area at its maximum diameter which is in normal activity under the conditions of operation of the furnace.

(2) The factors which control or determine the effective bosh area are those which are under discussion in this paper, namely, the condition of the materials charged, the furnace lines, and the volume of blast blown per minute in relation to the size of the furnace.

(3) The bearing these factors have upon the output capacity of the furnace is that they determine the area of activity in the melting zone.

The whole trend of evolution in blast-furnace practice has been in attempts to devise means of increasing output capacity, consistent, of course, with quality and economy, and the degree to which these attempts have been successful in modern practice has been due to the influence the factors in that practice, as described in this paper, have had in increasing the ratio of effective bosh area to the maximum or designed bosh area of the furnace, or, to put it in simple terms, *to keeping the walls clean*. It is, therefore, conversely true that the effective bosh area of blast-furnaces, where the factors upon which modern practice is based have not been adopted, or which are not operated in conformity with its principles, is less than the maximum or designed bosh area.

As has been described under Preparation of Materials, the direct tendency of lack of such preparation is towards restriction of active area in the furnace. Under furnace design the tendency of the high bosh and the low stack batter is shown to be towards restriction of active area in the furnace. Equally the tendency of the small hearth and flat bosh angle is towards restriction of effective bosh area, owing to the removal of the area at and adjacent to the top of the bosh near the walls too far horizontally from the upward moving gases, with the consequent tendency for accumulation of torpid or stationary materials in that area.

As previously described, for a furnace of given size, insufficient blast volume to ensure equal activity throughout the whole cross-section at every altitude tends to the production of inactive areas owing to the impossibility of providing perfect uniformity of materials. The greater this lack of uniformity, the greater this tendency. The under blowing of a blast-furnace is one of the most fruitful causes of reduction of effective bosh area, with outputs far below maximum output capacity.

The tendency of a blast-furnace is to adjust its active areas to the volume of blast supplied to it. This tendency is in strong evidence where furnaces which have been blown for a considerable period with comparatively small blast volume, have been suddenly and too quickly supplied with a considerably increased volume. Operators who have made this experiment will doubtless recall the difficulties they have experienced through irregular working. The author knows of cases where, although the furnace size was quite suitable to the increased blast volume, the attempt has been abandoned through the conclusion that conditions were not suitable to faster driving, whereas a little persistence would probably have overcome the difficulties met with by the walls gradually clearing, and the furnace thus adjusting itself to the larger blast volume.

It is, of course, true that many blast-furnaces in operation to-day are not adaptable to modern practice in its fullest sense. One or more of the necessary factors are lacking, and, as the author has attempted to show, each of these factors is so dependent upon the others that they must all be present for its full application. Among them, however, there is one, preparation of materials, which, if adopted alone, would provide conditions which would render possible the partial application of others with decided improvement in results, and tend to remove many of the difficulties now experienced.

(To be continued.)

NEW SOUTH WALES RAILWAYS.

For the year ended June 30th last the report of the Commissioners for the New South Wales Railways shows a deficit of £121,164. While this is an improvement on the previous year's transactions, there should have been much more favourable results consequent upon the traffic dealt with and the additional increases in rates and fares compensating for the higher costs, although the natural increase in traffic has been retarded by the inflated charges.

The disastrous effect of the excessive rates is particularly noticed in the passenger traffic, for while the number of passengers carried during the previous fourteen years increased at an annual average rate of 6,388,004, the increase for the past year was only 563,721, and this retardation has been further accentuated by the change from first to second class.

Passenger Journeys.—Year 1922 Compared with Year 1921.

	First-class, decrease, No.	Second-class, increase, No.
Suburban	1,801,395	2,467,445
Country	156,983	54,854

Nevertheless the revenue for the year increased to the extent of £198,360. There was also a decrease in the carriage of goods traffic, but whilst that under 2d. per ton-mile declined by 55,762,788, that over 2d. gained by 3,337,748 ton-miles, so that in all there was an increased revenue of £1,349,973, with a saving in haulage of 52,425,040 ton-miles.

	Year ended June 30th. 1922.	1921.
Total capital expended ..	£85,532,871 ..	£82,304,194
Total miles open for traffic ..	5,116 ..	5,042¼
Average miles open for traffic	5,077 ..	5,018¼
Gross earnings	£15,213,019 ..	£14,267,205
Working expenses	£11,116,302 ..	£11,032,677
Net earnings	£4,096,717 ..	£3,234,528
Interest on capital	£4,217,881 ..	£3,811,560
Deficit	£121,164 ..	£577,032
Number of passenger journeys	121,298,861 ..	120,735,140
Goods and livestock, ton-miles	1,365,960,947 ..	1,418,385,987

EDUCATIONAL INTELLIGENCE.

A GOLDSMID Engineering Entrance Scholarship at University College, London, value £30 a year, tenable for three years, has been awarded to Mr. T. A. L. Paton, of Cheltenham College.

A SPECIAL course of lectures on "The Strength of Materials and the Theory of Structures," will be delivered by Mr. R. E. Stradling, M.C., Ph.D., M.Sc., A.M. Inst. C.E., Head of the Department, at the Technical College, Bradford, during the current evening session, if sufficient students apply for admission. The course will be designed especially to meet the needs of students who wish to present themselves for the examination for the associate membership of the Institution of Civil Engineers. The course will be held from 7.15 to 9.15 on one night a week. The night of meeting will be arranged to suit the majority of students who may wish to join, and the fee for the course will be 15s.

In one of the largest buildings in Saskatoon, the concrete basement walls showed signs, according to the *Contract Record*, of being affected by alkali water. On the inside of the wall considerable incrustation had formed, and it was thus decided to excavate outside to a depth of 10ft. down to the footings. Two feet below the road the concrete was slightly affected and became worse further down to within 1ft. of the top of the footings. Disintegration had taken place to a depth of 4in., where it immediately stopped. It was found that a 2in. by 12in. spruce plank, waterlogged but in a perfect state of preservation, had been left in. Behind the plank the concrete was as solid as a rock. An examination of the excavation disclosed the ground water table about 3ft. below the surface, while the water was apparently rich in sulphates. As the building is eleven years old it is concluded that wooden cribbing with waterproofing joints, provides an excellent protection against the effect of alkali for a considerable period.

THE extremely high cost of transportation of motor spirit into the interior of the Belgian Congo, largely due to tsetse flies, which make it impracticable to use animals for transporting goods, and necessitates the use of native porters, led the Belgian Colonial Ministry to organise a trial of road tractors using palm oil as fuel. The results of these trials, according to the official United States "Commerce Reports," have opened up vast prospects for the development of Central Africa, and may be summarised as follows:—Palm oil, when used as sole fuel in semi-Diesel two or four-cycle engines, gave full satisfaction. The engines ran normally, and the power developed was equal to, if not greater than, that obtained with paraffin. Nothing was noted that suggested possible difficulties in using palm oil in these engines. Starting up, without motor spirit injection, was good, and there was no carbonisation. One large firm, which holds diamond and rubber concessions, possesses three tractors that run on palm oil, and has ordered two more, very satisfactory service being rendered by those which have been in operation.

A Seven-Day Journal.

Inter-Imperial Trade.

In the course of his speech in Edinburgh on the 31st ult. to the Scottish members of the Federation of British Industries, Colonel O. C. Armstrong, the retiring president of the organisation, devoted considerable attention to the question of inter-Imperial trade and the possibilities of developing it. The Overseas Dominions in 1921 took 15½ per cent. of our exports, but as their combined populations only amount to 22 million at present, their absorbing capacity as markets is obviously limited. While, too, their potential resources are vast, their present productive power is also limited by the relative smallness of their population. It would, therefore, in Colonel Armstrong's opinion, be unreasonable to expect a very substantial increase in our trade with Australia, New Zealand, Canada and South Africa until their populations have increased. While emigration would effect this result, emigration by itself is not sufficient unless there is a corresponding development of local industries. The fostering of such local industries should therefore be looked upon as a good investment for British capital. As regards India, Colonel Armstrong thought that the political situation in that country and its possible future fiscal policy would hamper any extension of British trade, and might even make it difficult for us to maintain it at its present level.

The Sound of Explosions.

With the object of studying the propagation of sound and its relation to the meteorological conditions in the upper atmosphere, the Dutch Ministry of War and the Dutch Royal Meteorological Institute some time ago made arrangements to set off 10 tons of high explosives at Oldebroek in Holland. A preliminary explosion led to protests by the inhabitants of a village four miles away, but an agreement having been made to pay compensation for broken windows and other damage, it became possible to carry out the test last Saturday. The explosion took place at 28 sec. after 5 p.m., Greenwich mean time. Five tons or so of ammonium perchlorate were used. It was not heard by observers with the unaided ear either in London or Paris, while even at the De Bilt Observatory, near Utrecht, not more than about 35 miles in a straight line from Oldebroek, the explosion was only detected by means of the seismograph. At the Signals Experimental Establishment, Woolwich, a very clear record of it was, it is stated, obtained by Major Tucker with his hot wire microphone, the sound waves being received about 21 min. after the initiation of the explosion. A less sensitive instrument at Biggin Hill also gave a measurable trace.

The Late Mr. E. A. Pratt.

We noticed with regret the death at Esher, Surrey, last Friday of Mr. Edwin A. Pratt, the well-known writer on economic and industrial subjects, and an authority on all aspects of land transport. Mr. Pratt was born at Wolverhampton in 1854, and at an early age joined the staff of the *Birmingham Mail* as sub-editor. Thereafter, he was associated with the *Manchester Evening Mail*, and for a period of about ten years with the London *Times*. Round about the beginning of the century, he gave up journalistic work in order to devote his time to the study of economic, sociological and industrial problems. Among his books published during this later period of his life were "Trade Unionism and British Industry," "The Organisation of Agriculture," "A History of Inland Transport and Communication in England," "The Rise of Rail Power in War and Conquest, 1833–1914," "British Railways and the Great War," and, quite recently, "Scottish Canals and Waterways." All his works and articles were characterised by a remarkable lucidity of style and by the obvious pains taken to secure accuracy.

Gas by the Therm.

The reports for the quarter which ended on September 30th have been received this week from the Gas Referees appointed by the Board of Trade under the Gas Regulation Act, 1920. They are designed to show how the gas companies are fulfilling their statutory obligations as laid down in that Act and provide a sidelight on the controversy which still prevails regarding the therm and its merits as a unit from the consumers' point of view. The reports received relate to the gas undertakings in the London district. All the companies concerned are required to supply gas free from any trace of sulphuretted hydrogen and at not less than 2in. of water pressure. They are in all cases certified to have done so during the quarter. They are also required to supply the gas with a calorific value of not more than 6 per cent. below the figure prescribed for them, and here, again, they are certified to have fulfilled their obligations. The prescribed value differs from company to company, and it is interesting to note how it is fulfilled by each undertaking. The South Suburban and the Brentford gas companies are each required to supply gas of an average calorific value of 460 B.Th.U. gross per cubic foot. The average values as measured during the quarter were 477.7 and 471.2 respectively. The Wandsworth Company, with a prescribed value of 470, supplied gas with an average calorific value of 479.7 B.Th.U. per cubic foot. For the Commercial Gas Company the prescribed value is 475, and the certified realised value 492. The Gas Light and Coke Company, with 500 as the prescribed figure, just got through with 501.6; while the South Metropolitan, with 560 prescribed, realised 565. Consumers should note that the quarterly accounts are, or should be, based on the prescribed and not the realised value. In other words, all the heat units above the prescribed value should be presented to them free of charge. It may be useful for the purpose of checking the accounts if we add that 1000 cubic feet are equal to P/100 therms, where P is the prescribed value.

Gliding.

Following upon the remarkable performances on the Sussex Downs during the recent gliding competition, it is stated that a London gentleman has offered another prize of £1000 for a contest next year. Details, it is said, are at present being discussed with the Royal Aero Club, the body responsible for the organisation of the recent trials. It is understood that the basis of the competition will not be simply duration of flight without reference to the distance or route covered, but length of flight from point to point. The minimum distance to be flown in order to qualify for the prize will be considerable, one report placing it at 50 miles. Such a flight could, of course, only be accomplished by starting from a very high hill or mountain and by pursuing a course over a tract of land the configuration or condition of which was such as to assist the machine to maintain or regain its original altitude. It does not seem probable that a glider can be constructed to glide at an angle of less than 1 in 25, so that to make a flight extending to 50 miles, a start would have to be made from a hill two miles in height, or two and a-half times as high as Ben Nevis. On the other hand, a considerably lower altitude would serve if the route chosen lay over land which was such that at convenient intervals the pilot would encounter up draughts of air of sufficient strength to enable him to recover all or most of the height lost during the immediately preceding gliding period. Even although a 50-mile glide should be accomplished, it is clear that gliding as a means of transport from any point to any other at any time will be scarcely more practicable than it is at present.

The Shipyard Ballot.

About the middle of September the Shipbuilding Employers' Federation entered into negotiations with the engineering and shipbuilding trades unions to secure the abolition of the remaining 10s. per week of the war bonus of 26s. 6d. On a ballot being taken as to whether the employers' terms should be accepted or rejected or whether the union representatives should be empowered to renew the discussions in order to obtain the best possible conditions, a large majority of the men, it will be recalled, voted in favour of the latter alternative. Negotiations were therefore resumed, and resulted in the employers modifying their proposal to the extent of fixing a minimum wage of 37s. 6d. per week, and of making the abolition of the bonus effective in three stages, and not in one as originally intended, the first reduction to come into force on the 1st of this month. According to plan, the acceptance or rejection of this modified proposal had to be submitted to the men in a second ballot. The result of that ballot was announced on Monday, and showed a vote of 22,459 in favour of acceptance and one of 39,959 for resisting by a strike. The majority in favour of resistance thus just falls short of the two-thirds figure required by the Federation rules before a strike can be called. A meeting has been arranged for to-day—Friday—between the employers and the union representatives. Meanwhile, the men have been advised by their leaders to remain at work pending the outcome of this meeting. It is noteworthy that whereas a total of nearly 90,000 votes were cast in the first ballot, only 62,000 odd were recorded in the second.

Varible Speed Aeroplanes.

While the Institution of Mechanical Engineers last Friday was discussing Professor Rateau's turbo-compressor as a means of attaining great speeds at high altitudes, M. Maneyrolle, the winner of the principal prize in the recent gliding contest, was demonstrating at Villacoublay the properties of a new aeroplane designed to secure the opposite result, namely, to fly slowly at low heights. Of the two problems, the latter is undoubtedly the more important practically at the present moment, for the primitive fact to be faced is that the endowment of an aeroplane with a high flying speed necessarily endows it with a high, and therefore dangerous, landing speed. Great consideration has been given by many designers to the provision of means whereby the usual landing speed of 45 to 50 miles an hour might be reduced without affecting the normal flying speed. The slotted wing, as advanced by Mr. Handley Page and others, is one attempt at a solution of this problem. A more obvious and popular one is to equip the machine with some form of variable wing surface. The machine tested by M. Maneyrolle is of the second form, and was designed by M. Bille. It is stated that the trials were satisfactory, the extension and reduction of the wing surface being carried out in a few seconds while the machine was in flight. After touching a top speed of 107 miles an hour, the pilot slowed the machine down to a speed of 37 miles, and finally landed at about 12½ miles an hour. If these figures are confirmed, and if the machine is found to possess undiminished strength and rigidity, its performance will mark a very notable development in aeronautics.

The Mauretania's Record.

After a three weeks' overhaul the Mauretania left Southampton last Saturday for her 275th crossing of the Atlantic. As a passenger ship, she has now steamed 850,000 miles and carried 375,000 passengers. Including her war services, the total length of all her voyages exceeds a million miles. It is claimed that no other liner now in service can approach these figures. The Mauretania not only holds all the speed records, but has achieved the remarkable performance of averaging 25½ knots on twenty-seven consecutive runs across the Atlantic, while on three successive occasions this year her trip times differed by less than five minutes. She will perform three more voyages across the Atlantic this year and then sail for the Mediterranean for an extended cruise.

An Anti-Corrosion Association.

In continuation of the paragraph in the Journal for July 21st, it has now to be recorded that a conference of manufacturers of anti-corrosive products was held at Caxton Hall, London, on Tuesday, and that this conference decided to form an association to develop and extend the uses of rust-proofing materials and preservatives for stone and timber. The organising secretary, Mr. W. R. Douglas Shaw, explained that while the Association would direct its chief attention to the prevention of rusting in steel and iron, its scope would extend to the preservation of timber and stone, and would even include such subjects as the scaling of boilers and the fouling of ships' hulls. The laundry and the building industries would, he thought, derive particular benefit from the activities of the Association.

Traffic Derangement on the Arlberg Railway.

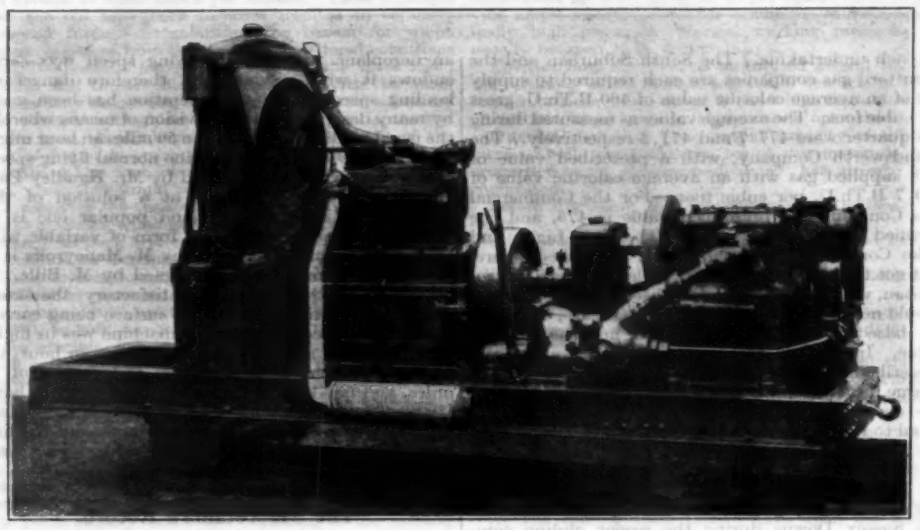
The work of electrifying the Arlberg Railway has now been proceeding for some months, and it is hoped that the line between Innsbruck and Landeck will be ready for operation in the early part of next year. In order to allow the heavier electric locomotives to pass over the Trisanna Bridge, it was necessary to insert strengthening members, and this work has been progressing steadily for some months. On Saturday morning last, after a heavy goods train had passed over, it was found that the bridge had sunk several centimetres, and all express traffic was forthwith stopped, the expresses being diverted over the Lindau–Munich line to Vienna. Slow trains were allowed to proceed as far as the bridge head on either side, and the passengers had to walk over the bridge, special safety and lighting arrangements being improvised. The work of repair will take several days. The bridge has a span of 150 m., and is 86 m. high, measured from the river bed. It is the second largest bridge in Austria.

The Weir-Sulzer Diesel Engine.

We learn that G. and J. Weir, Limited, of Cathcart, have for some time been closely investigating the general design and characteristics of various types of internal combustion engines for marine auxiliary purposes. They are conscious of the vital necessity of providing a type of engine which would be trustworthy, simple and economical in capital outlay. The future success and development of the motor ship appears, in their view, to depend upon the first cost being reduced, and, at the moment, the first cost of really high-grade auxiliary engines is distinctly high. As a result of their investigations they have decided to adopt an entirely new type of Diesel engine, recently perfected by Sulzer Brothers, of Winterthur, one of the most experienced firms in Diesel engine design and construction. They have arranged to build the engine in this country for auxiliary use on board ship. It will be known as the Weir-Sulzer type.

WAVE GENERATING PLANT FOR BOMBAY

W. H. DORMAN AND CO., LTD., STAFFORD, ENGINEERS



Wave Transmission of Power.

No. II.*

From what was said in our first article it will have been gathered that the wave transmission of power consists in brief of impressing a constant mean pressure on a column of water or other fluid and, on top of it, a rapidly varying periodic pressure giving rise to a continuous train of compressions and rarefactions in the water, the point of generation of the waves being connected to the point at which they are applied by a pipe the length of which is some multiple of half the wave length of the waves generated. In any given case the wave length in feet is expressed by V/n, where V is the velocity of sound in water, approximately 4800ft. per second, and n is the speed of the generator—assumed single-acting—in revolutions per second. No great precision in the exact length of the pipe is essential, for not only is there little loss of effective pressure by making it somewhat greater or less than an exact multiple of the half wave length, but, as has been found by experience, the speed of the generator automatically adjusts itself to any moderate variation in the length of the pipe provided the pipe is not unduly short. Further, it is by no means essential that the pipe should have a straight run from the generator to the rock drill or other appliance being driven. The waves pass practically unaffected round bends in the pipe, and in this respect wave transmission permits as much freedom in the run of the pipe as does ordinary hydraulic or compressed air transmission of power.

In practical use, then, wave transmission may, as regards the equipment required, be divided into three portions—first, the generator; secondly, the connecting pipe; and, thirdly, the apparatus driven by the waves. As regards the third item, we shall take it to be a rock drill, for developments in that direction have reached the most advanced stage. It should, of course, be clearly understood that other forms of percussion appliances, such as a riveting machine, are equally practicable. Moreover, as we stated in the first article, the adaptation of wave transmission to the generation of rotary motion has passed through a large portion of the experimental stage and is now about to be developed with a view to its commercial applications.

A rock-drilling equipment recently completed by Messrs. Dorman at Stafford for the Bombay Municipality consists of two generators and an equipment of rock drills and piping, each generator being capable of operating three rock drills simultaneously. We give a general view of one of the generating sets above. It is a self-contained unit, the engine, generator, &c., being mounted on a four-wheeled 2ft. 6in. gauge steel channel trolley. The engine is one of Messrs. Dorman's standard designs, and has an R.A.C. rating of 36 horse-power. The radiator and fan are mounted on top of a fuel tank extending across the trolley in front of the engine. The engine and generator are coupled through a clutch and a gear-box which raises the engine speed of 1200 revolutions per minute to 2400 at the generator. A similar type of generator has now been in commercial use for over nine months in a quarry supplying material required in connection with the new sewage works of the Bradford Corporation.

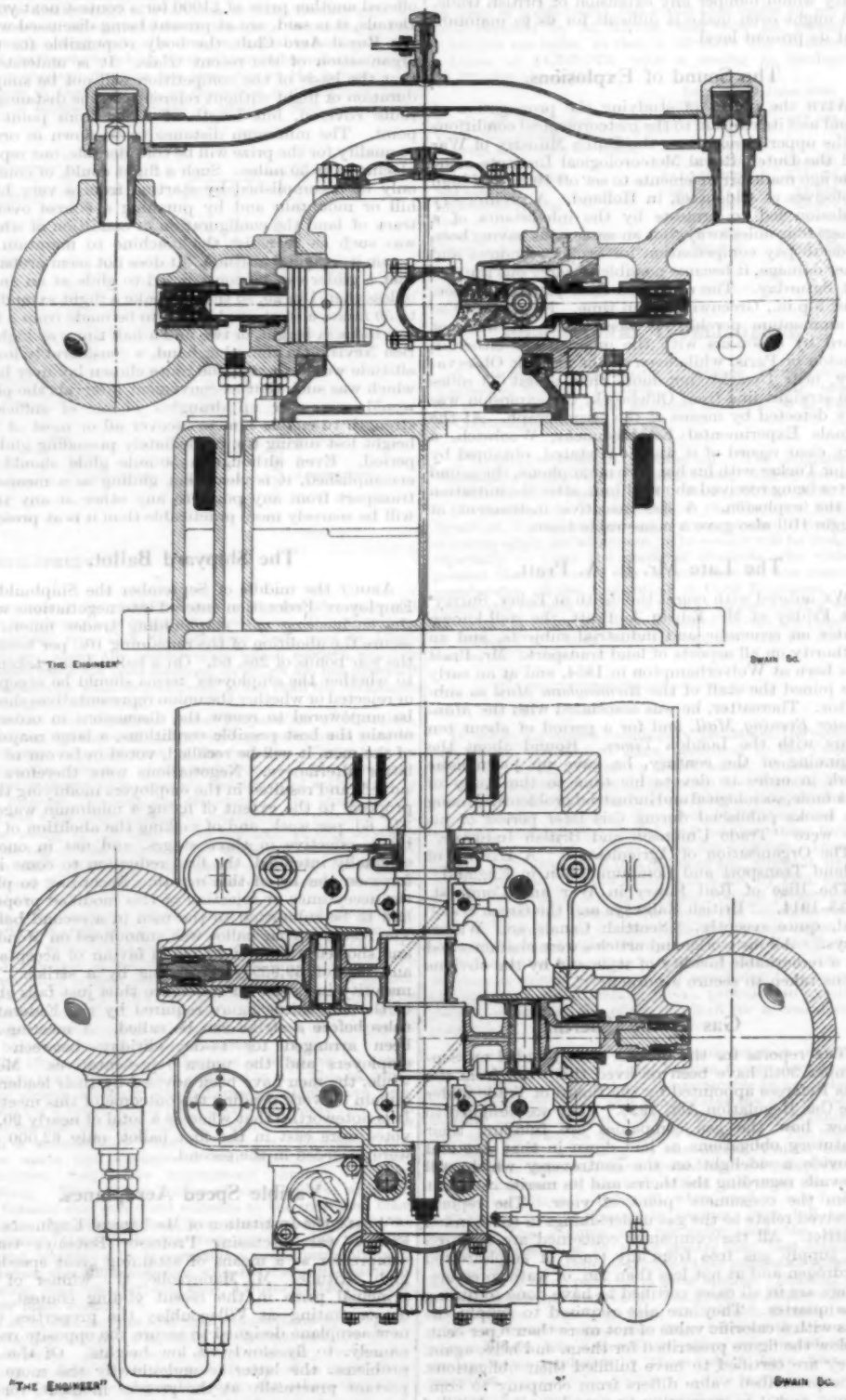
Before considering the design of the generator it may be made clear that the flow of flushing water required at the point of the drill is supplied by the generator virtually as a leak from the transmission water. Make-up water has thus to be provided, but it is clearly to be understood that apart from this supply, which has nothing to do with the system as a means of transmitting power, a highly important characteristic of wave transmission, distinguishing it from ordinary hydraulic or compressed air transmission, is the fact that there is no exhaust of the working fluid, and therefore neither loss of the fluid nor of the residual energy contained in it after it has done its work.

* No. I. appeared October 27th.

The Wave Generator.

The actual wave generator illustrated in Figs. 2, 3, and 4 is somewhat smaller than those supplied to Bombay, but differs from them in no essential principle. Its speed is the same—2400 revolutions per minute—but its output is suitable for the operation of only one rock drill at a time. The crank shaft, carrying a fly-wheel, is formed with two side-by-side cranks at 180 deg. each, with a throw of about ¾in. Very short connecting-rods couple the cranks to the plungers. The latter, it will be noticed, are bored out for the sake of reducing their inertia, and are formed solidly with piston-like crossheads. The plunger ends are equipped with triple cup leathers, and work within bushes fixed in the walls of two spherical chambers known as "capacities." The two capacities are in constant communication with each other by way of a cross pipe and socket fittings entering the tops of the chambers. A connection to the transmission pipe is taken from either of the capacities.

The plungers have a diameter of about 1¼in. It follows, therefore, that with a stroke of ¾in. the total diminution of the united volumes within the capacities experienced once per revolution of the crank shaft is approximately 2.65 cubic inches. From the known



FIGS. 2 AND 3—VERTICAL AND HORIZONTAL SECTIONS OF WAVE GENERATOR

moduli of elasticity of water and steel it is calculated that of this volume 94 per cent. is represented by the compression of the water and only 6 per cent. by the elastic expansion of the capacities, transmission pipe, &c.

On top of the crank case a "breathing" device is provided, which is designed to obviate the ingress of dust and grit and to permit the passage of air into and out of the crank case in tune with the movement of the pistons. Experience has shown that the compression of the air inside the crank case when it is completely closed is without significant effect, and consequently in later designs of generator the breathing device is dispensed with. On the other hand, an important fitting is the air outlet valve situated at the mid point of the pipe connecting the two capacities. This fitting provides an outlet for the air in the system when it is being primed with water on being first started. It is very important to get rid of all loose air in the transmission pipe, &c., for were any allowed to remain it would materially upset the transmission of the waves in the intended manner. On the other hand, air actually dissolved in the water does not exercise sufficient effect to justify the considerable amount of trouble that would be required to secure its removal.

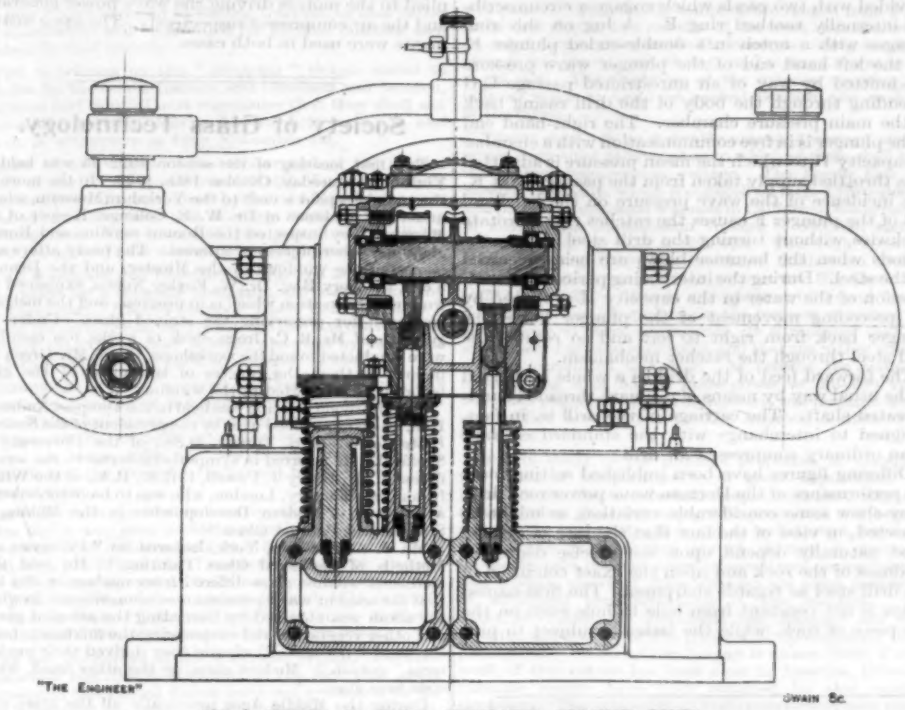


FIG. 4—SECTION OF WAVE GENERATOR THROUGH PUMPS

From the end of the crank shaft a worm and worm wheel drive conducts power to a short cross shaft provided with ball and ball thrust bearings, and carrying two excentrics which drive through ball and socket joints on to the end of two spring-loaded plungers. The plunger on the right in Fig. 4 maintains a constant supply of oil under pressure to all the bearings. The plunger on the left is used for priming the capacities and pipe line in the first instance, for applying and maintaining the constant mean pressure on the water, and for supplying the make-up water to the system to replace that lost in the flush from the drill point. The plunger chamber is connected by pipe to an air vessel, whence the water is delivered past a non-return valve into one of the capacities. A spring-loaded relief plunger is provided in the plunger chamber, the spring of which is set to suit the mean pressure which it is desired to maintain in the system. When that pressure is reached the non-return valve offers greater resistance to opening than the relief plunger does to rising. The relief plunger thus rises and descends with the descent and rising of the delivery plunger, with the result that the supply of make-up water to the capacity is automatically closed down until the mean pressure falls again to the predetermined value.

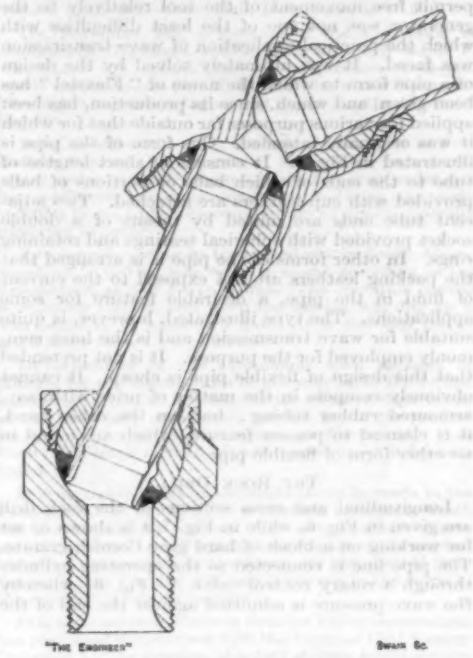


FIG. 5—FLEXSTEL PIPING

In the Bombay generator plant the chief difference in the design consists of the use of a single capacity in the form approximately of an oxygen cylinder and lying across the trolley as a separate unit between the generator and the gear-box. The connections between the generator and the capacity are made by means of short lengths of the "Flexstel" piping described below. The object sought in so doing is not so much to provide for any possible relative displacement

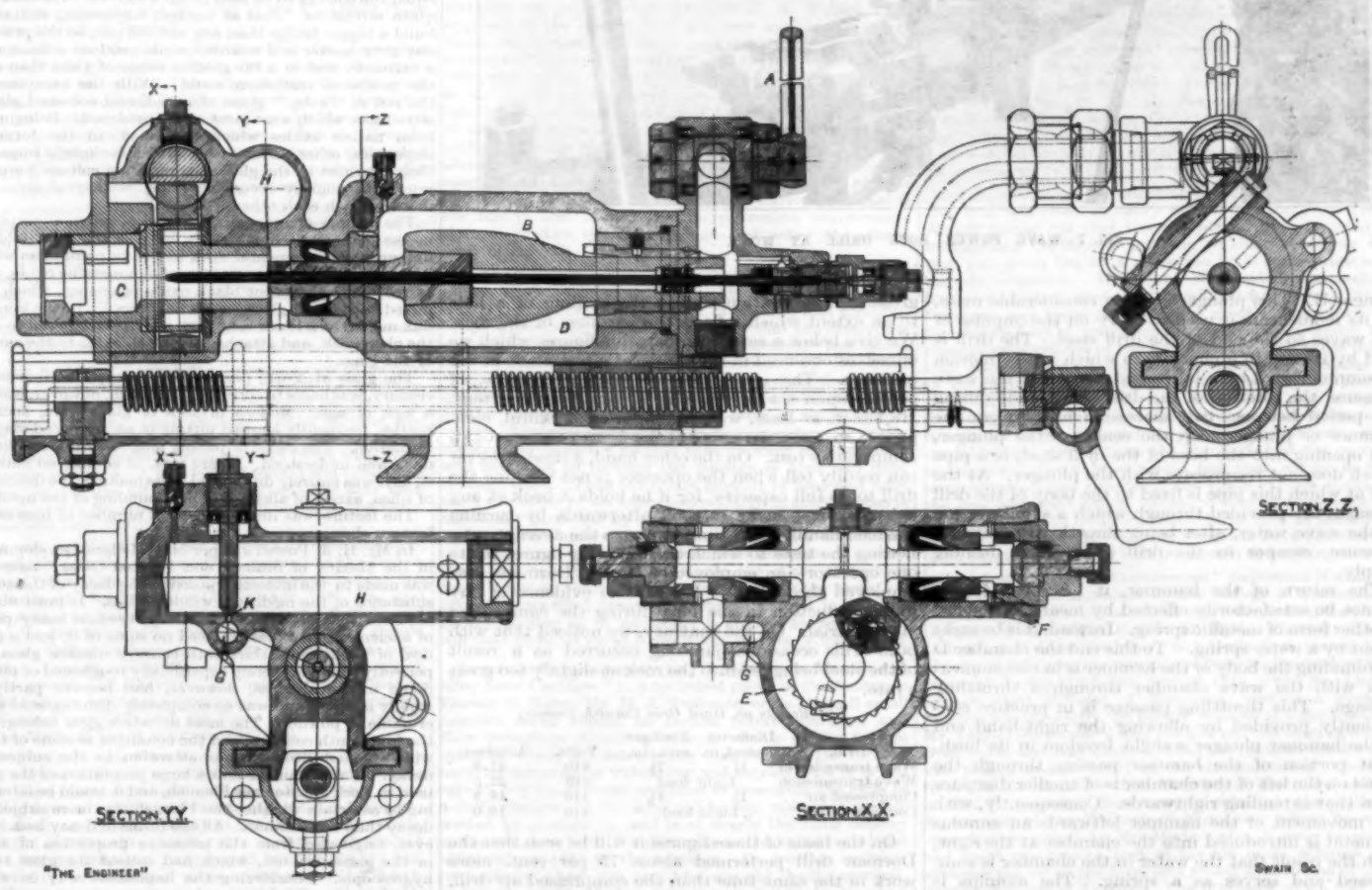


FIG. 6—LONGITUDINAL AND CROSS SECTIONS OF WAVE POWER ROCK DRILL

between the generator and the capacity, but rather to provide a means of obtaining a tight connection without calling for very accurate alignment of the parts connected and thus to simplify and cheapen assembly.

"Flexstel" Piping.

The problem of providing a pipe sufficiently strong to withstand the high local pressures created in the water and at the same time sufficiently flexible to permit free movement of the tool relatively to the generator was not one of the least difficulties with which the practical application of wave transmission was faced. It was ultimately solved by the design of a pipe form to which the name of "Flexstel" has been given, and which, since its production, has been applied for various purposes far outside that for which it was originally intended. One form of the pipe is illustrated in Fig. 5. It consists of short lengths of tube to the ends of which balls or portions of balls provided with cup leathers are attached. Two adjacent tube ends are united by means of a double socket provided with spherical seatings and retaining rings. In other forms of the pipe it is arranged that the packing leathers are not exposed to the current of fluid in the pipe, a desirable feature for some applications. The type illustrated, however, is quite suitable for wave transmission and is the form commonly employed for the purpose. It is not pretended that this design of flexible pipe is cheap. It cannot obviously compete in the matter of price with, say, armoured rubber tubing; but, on the other hand, it is claimed to possess features which are found in no other form of flexible pipe.

The Rock Drill.

Longitudinal and cross sections of the rock drill are given in Fig. 6, while in Fig. 7 it is shown as set for working on a block of hard grey Cornish granite. The pipe line is connected to the operating cylinder through a rotary control valve A—Fig. 6—whereby the wave pressure is admitted against the end of the plunger B. This plunger is given considerable mass, for its momentum is used to carry on the impulse of the waves to the end of the drill steel. The drill is held by its end in a chuck C to which rotary motion is communicated by a by-passed portion of the wave pressure, the rotation of the drill being made during the period between two successive blows from the hammer or plunger. Up the centre of the plunger, and opening into the bore of the drill steel, is a pipe which does not reciprocate with the plunger. At the end at which this pipe is fixed to the body of the drill passages are provided through which a small portion of the wave water, after being throttled to a steady pressure, escapes to the drill point as a flushing supply.

The return of the hammer, it has been found, cannot be satisfactorily effected by means of a spiral or other form of metallic spring. Instead, it is brought about by a water spring. To this end the chamber D surrounding the body of the hammer is in communication with the wave chamber through a throttling passage. This throttling passage is in practice conveniently provided by allowing the right-hand end of the hammer plunger a slight freedom in its bush. That portion of the hammer passing through the gland on the left of the chamber is of smaller diameter than that extending rightwards. Consequently, with the movement of the hammer leftwards an annulus of metal is introduced into the chamber at the right, with the result that the water in the chamber is compressed and serves as a spring. The annulus is designed to be of greater volume than can be accommodated by the compression of the water, the surplus being represented by a small leak which is allowed to take place.

A fair amount of practical difficulty was found in devising a satisfactory means of packing the glands, &c., both of the drill and of the generator. In the form finally adopted the packing material is cotton impregnated with graphite and rubber. The bush on the pressure side is made with a slight clearance sufficient to throttle the wave motion and to result in the application to the packing of a steady hydraulic pressure equal to the predetermined mean pressure.

The rotation of the drill chuck is effected by a ratchet mechanism, which, in effect, constitutes an elementary form of wave transmission rotary motor. The chuck in which the drill steel is held is provided with two pawls which engage a circumscribing internally toothed ring E. A lug on this ring engages with a notch in a double-ended plunger F. To the left-hand end of the plunger wave pressure is admitted by way of an unrestricted passage G G extending through the body of the drill casing back to the main pressure chamber. The right-hand end of the plunger is in free communication with a chamber or capacity H to which the mean pressure is admitted by a throttled supply taken from the passage G at K. The incidence of the wave pressure on the left-hand end of the plunger F causes the ratchet ring to rotate clockwise without turning the drill steel during the periods when the hammer blows are being received by the steel. During the intervening periods the compression of the water in the capacity H produced by the preceding movement of the plunger forces the plunger back from right to left and so rotates the drill steel through the ratchet mechanism.

The forward feed of the drill as a whole is effected in the usual way by means of a square-threaded hand-operated shaft. The carriage of the drill is, in fact, designed to interchange with the standard carriage of an ordinary compressed air drill.

Differing figures have been published setting forth the performance of the Dorman wave power rock drill. They show some considerable variation, as might be expected, in view of the fact that the rate of drilling must naturally depend upon the precise degree of hardness of the rock and upon the exact condition of the drill steel as regards sharpness. The first-named factor is not constant from hole to hole even on the one piece of rock, while the latter is subject to progressive deterioration during the drilling of a hole to an extent which reflects the hardness of the rock. We give below a set of comparative figures which we ourselves observed in the course of a test made in our presence. The exact rate of drilling depends, of course, upon the operator to a considerable extent. He has it, at least, within his power, if skilful, completely to upset the value of the figures obtained in a comparative test. On the other hand, a close observer can readily tell when the operator is not working the drill to its full capacity, for if he holds it back at any time he must make it good afterwards by turning the feed handle for a time at above the average rate. During the tests to which the following figures relate one operator—an employee of Messrs. Dorman—was employed throughout. We saw no evidence of any undue reduction in the feed during the compressed air drill trial. On the contrary, we noticed that with both drills occasional jambing occurred as a result of the steel being fed into the rock at slightly too great a rate.

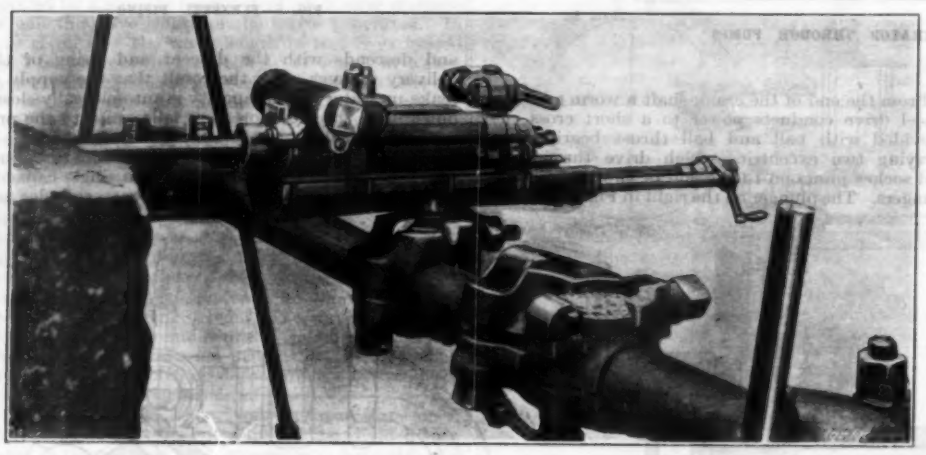


FIG. 7—WAVE POWER ROCK DRILL AT WORK

Test Results on Hard Grey Cornish Granite.

Drill.	Diameter of steel, in.	Feed per min., in.	Volts.	Amperes.
Wave transmission	1¼	7½	410	37.5
Wave transmission	Light load		410	22.5
Compressed air	1¼	4½	410	48.5
Compressed air	Light load.		410	18.0

On the basis of these figures it will be seen that the Dorman drill performed about 75 per cent. more work in the same time than the compressed air drill, and consumed in so doing about 25 per cent. less power. When running with the drill out of action, the Dorman drill consumed 25 per cent. more power. The figures for the Dorman drill include the energy required to supply the flushing water. In the case of the compressed air plant the flushing water was supplied by a separate pump, the energy consumption of which was not measured. The compressed air drill was of a modern type—we cannot obviously specify its design—and was supplied by an air compressor of equally modern form. The compressor was not unduly large. In fact, it was only just large enough to drive the drill, as was shown by the fact that the receiver pressure fell slightly—from 82 lb. to 75 lb. per square inch—when the drill was brought into full action. It will be understood that the electrical consumption figures represent the energy supplied to the motors driving the wave power generator and the air compressor respectively. The same instruments were used in both cases.

Society of Glass Technology.

The first meeting of the session 1922–23 was held at York on Wednesday, October 18th, 1922. In the morning the members paid a visit to the Yorkshire Museum, where, under the guidance of Dr. W. E. Collinge, Keeper of the Museum, they inspected the Roman remains and Roman glass and other objects of interest. The party afterwards inspected the windows of the Minster, and the Dean of York, the Very Rev. Dr. W. Foxley Norris, explained the work of preservation which is in progress, and the methods employed for preserving the stained glass. Under the guidance of Mr. R. C. Green, clerk of works, the members were conducted round the workshops, where Mr. Green explained to them the process of treatment of the glass before it is re-inserted in the windows.

The afternoon meeting was held in the Tempest Anderson Hall, and was presided over by the president of the Society, Professor W. E. S. Turner, D.Sc., of the University of Sheffield. He referred in sympathetic terms to the serious illness of Mr. Harry J. Powell, C.B.E., B.A., of the Whitefriars Glass Factory, London, who was to have contributed a paper on "Modern Developments in the Making of Stained and Painted Glass."

Mr. J. A. Knowles, York, lectured on "Processes and Methods of Mediæval Glass Painting." He said that mediæval window glass differed from modern in the fact that the ancient was a potassium-calcium-silicate, in which the alkali was obtained by lixiviating the ashes of plants and other vegetation and evaporating the mixture; hence the word "pot-ashes," whence they derived their modern term "potash." Modern glass, on the other hand, was a soda-lime glass.

During the Middle Ages practically all the glass used for painted windows was imported. The northern school of glass painting situated at York drew its glass from the nearest source, the northern continental glass-making districts of Hesse and other Rhenish provinces. The London school was supplied from Lorraine, Burgundy and Normandy. There was a great difference between the two. The uncoloured glass used in the North was much whiter than that employed in the South. Probably there was more English-made white glass used there, derived from the glass works at Chiddingfold.

It was frequently stated that there were no colours to equal the colours to be seen in old windows. The idea was quite erroneous. Just as modern engineering skill could build a bigger bridge than any ancient one, so the present-day glass maker and scientist could produce colours with a certainty and in a far greater range of tints than ever the mediæval craftsmen could. With the exception of the red or "ruby" glass, the mediæval coloured glasses were those which were most easily produced. Being made from native oxides which contained, in the form of impurities, other metals, each of which slightly imparted their own tint to the glass, the resulting colours were not pure, but slightly secondary; hence they always harmonised with each other.

The colours such as red, blue and green were contained in the glass itself, but details such as the face, folds of drapery, and ornamental work had to be painted on with a brown vitrifiable pigment, formed of a metallic oxide, such as red oxide of iron or black oxide of copper, which was mixed with a soft glass known as "flux." In the kiln the flux melted at a lower heat than would be required to melt the glass itself, and attached the black oxide to the surface of the glass.

The glass at York, particularly that of the fourteenth century, was liable to corrode. Corrosion, however, was not a sign of age. Modern articles of glass ware, such as bottles, frequently showed pitting in an advanced stage of formation. The cause of pitting and corrosion was nowadays well understood. There was, of course, no cure for it, as it was entirely due to bad glass making, the deficiency of silica, excess of alkali, and bad founding of the metals.

The lecture was illustrated by a number of interesting lantern slides.

In Mr. H. J. Powell's paper on "Modern Developments in the Making of Stained and Painted Glass" reference was made to the interest aroused in the decay of the actual substance of the mediæval window glass. It must not be assumed that decay was necessary, because many pieces of ancient Roman glass showed no signs of it, and a good deal of twelfth and thirteenth century window glass was perfectly sound or merely superficially roughened or pitted. Some mediæval glass, however, had become partly or wholly opaque, and was so completely disintegrated as to crumble to powder. The most defective glass belonged to the fourteenth century, and the condition of some of these windows first drew serious attention to the subject of decay. It was claimed that a large proportion of the glass used in York Minster was Flemish, and it would be interesting to ascertain whether the Flemish was more subject to decay than the Norman. All the forms of decay had, however, originated from the excessive proportion of alkali in the glass mixture, which had caused the glass to be hygroscopic. Considering the haphazard way in which the alkali was added to the glass mixture by the mediæval glass makers, it was more remarkable that a large proportion of mediæval glass had survived than that a small proportion had failed.

The report of Major Hall on the Gravesend collision of August 21st is alluded to in our notes for October in the opening pages of this issue.

Railway Matters.

The New York Central system is working out a plan whereby trainmen will be paid a premium for expediting the movement of their trains.

The London and North-Western Company's Croxley Green branch—off the Watford-Rickmansworth branch—has now been converted to electric traction, so that better communication will be afforded for London business men resident in that vicinity.

The restriction on the "shopping" tickets issued to London by the South-Eastern and Chatham and London, Brighton and South Coast companies that they shall not be available by trains leaving London between 5 p.m. and 6 p.m. is withdrawn as from November 1st.

Some of the wheels of the tender and of the leading coach of one of the London and North-Western morning expresses from Blackpool and Lytham to Manchester were derailed near Moorside and Wardley Station on Monday morning last. The train had just passed the Walkden water troughs. There were no personal injuries.

The Welshpool and Llanfair Railway is a 2ft. 6in. gauge line owned by a separate company, and was worked by the Cambrian. The Welshpool Town Council made a loan to the owning company when the line was constructed, and now that the railway is being absorbed by the Great Western it is to receive back 80 per cent. of the loan.

Orders have been received in Crewe railway works for a large number of locomotives for the London and North-Western Railway. Thirty engines of a very powerful type are to be built immediately, and others will follow. A large order for new boilers has also been received, and the works at Crewe will be busy for a considerable time.

Like the railways of this country, those of the United States had a very good accident record for the year 1921. There were 5102 collisions and 13,615 derailments, as compared with 10,110 and 22,477 respectively in 1920. Passengers killed and injured in train accidents numbered 110 and 2601 respectively, as against 95 and 4631 in 1920, and the servants killed and injured in train accidents were 195 and 1296, as compared with 422 and 3385.

The service bureau of the American Wood Preservers' Association has drawn attention to the fact that many engineers in the United States have not awakened to the knowledge that sap wood of most species of timber is, after treatment, as immune to decay as heartwood. They still specify for "all heart," "85 per cent. heart," &c., and the restriction means a great waste, especially of Southern pine, and an increased cost for what is used.

Terms for the amalgamation of the Furness, Glasgow and South-Western and Highland with the London and North-Western and Midland railways in the North-Western, Midland and West Scottish Group have now been agreed upon. The North Staffordshire and Caledonian are to be included in the same group, but no mention of those companies has as yet been made. Terms for the absorption by the Midland of the Yorkshire Dales Railway have been settled.

Some idea of the activity with which the Argentine Government is prosecuting its railway construction programme may be gained from the statement that over 4000 kms. are being built in different parts of the Republic, and a few weeks ago tenders were closed for the suppy ofl 100,000 tons of rails and fastenings. British, French, German, Belgian and American manufacturers submitted offers, prices ranging between 42 and 52 gold pesos per ton, or approximately £8 and £10 per ton.

It is announced that the amalgamated companies in the Eastern, North-Eastern and East Scottish Group are to be known as the London and North-Eastern Railway Company. It will have a board of twenty-six directors—nine elected by the North-Eastern, four each from the Great Central, Great Eastern, Great Northern, and North British, and one from the Great North of Scotland, and the chairman will be Mr. William Whitelaw. Viscount Grey of Falloden is one of the North-Eastern nominees.

A new model for "couchette" sleeping cars to be used on trains de luxe was recently inspected by M. Le Trocquer, and this model will shortly be introduced on the great international routes. Each carriage weighs 53 tons, and is entirely constructed of metal. The compartments contain only one couchette each, and are fitted with every modern convenience. A new type of second and third-class sleeping car for use on the State railways has also been designed, and in a fortnight it will be running on the Paris-La Rochelle line.

The sum payable to the Irish railways for compensation, corresponding to the sixty millions granted to the British railways, was three millions. This amount, under the Irish Railways (Settlement of Claims) Act, 1921, was paid in one sum, and not in moieties as with the British, and was to be divided among the companies as they should agree, or, failing agreement, as determined by a commission. A resort had to be made to a commission, which recently awarded £2,500,000 to the seven larger companies and the balance among the remainder. The Great Southern and Western gets £879,000, the Great Northern £671,000, and the Midland Great Western £367,000.

According to the Board of Trade returns, the value of the railway material exported during the nine months ended September 30th last was as follows, the corresponding figures for 1921 and 1920 being added in brackets:—Locomotives, £3,783,202 (£5,924,294, £4,008,059); rails, £1,950,135 (£2,218,421, £1,876,177); carriages, £1,306,345 (£1,174,059, £1,236,811); wagons, £2,587,740 (£4,338,665, £3,868,603); wheels and axles, £985,356 (£1,379,012, £1,405,777); tires and axles, £328,363 (£1,017,811, £996,120); chairs and metal sleepers, £1,061,251 (£973,931, £876,326); miscellaneous permanent way, £1,087,939 (£2,003,272, £1,743,730); total permanent way, £6,154,383 (£7,780,712, £6,990,926). The weight of the rails exported was 193,020 tons (107,838 tons, 96,446 tons), and of the chairs and metal sleepers 117,916 tons (40,726 tons, 41,040 tons). During September alone locomotives to the value of £322,889 were shipped to Europe, and of £94,897 to India. Rails to the value of £53,633 were shipped to Australia, and of £38,885 to India.

Notes and Memoranda.

When building a reinforced concrete railway bridge at Waterloo, Iowa, during last winter, the contractors used a covering of manure to prevent the concrete from freezing. The manure was packed round the forms before the concrete, which was heated to 60 deg. Fah. in the mixer, was poured. The outside temperature ranged from 2 deg. to 36 deg. during two months of the work, but the lowest recorded temperature inside the concrete ninety-six hours after it was placed, was 59 deg., and some of it was as hot as 85 deg. The thickness of the manure covering was only so much as could be packed between the studding of the forms.

There seems to be a rivalry among American electric power companies at present as to which of them shall have the highest transmission voltage. The Pacific Gas and Electric Company, which is engaged on large hydro-electric and power transmission schemes in California, has arranged to increase its transmission voltage to 195,000, and by the beginning of 1923 to 220,000. This high record is being challenged by the Southern Californian Edison Company, which proposes to convert its Big Creek line to 232,000 volts. Already an experimental line of 7 miles in length is being employed for the purpose of testing the insulators and other equipment. It is reported that the experiment has been successful, and that the higher voltage will be introduced this year. At present the company is supplying over 85,000 horse-power at 150,000 volts, but when plans have been completed it will transmit about one million horse-power to Los Angeles, a distance of 240 miles.

In any study of the physical properties of materials, the effect of temperature is of great importance. It is well known that at a certain temperature ferro-magnetic materials lose their ferro-magnetic properties and become very feebly magnetic. It is not so well known, however, that certain more or less abrupt changes in magnetic properties take place at lower temperatures during heating and cooling, and that these changes are often indicative of structural transformations in the material. The American Bureau of Standards has designed and constructed apparatus for the purpose of investigating these phenomena. So far as the Bureau is aware, little, if any, work of this nature has been done in America, although valuable results have been obtained by this method elsewhere. The operation of the apparatus is now under investigation, and it should soon be available for study of the magnetic transformations taking place in ferro-magnetic materials upon heating or cooling.

In the process of relaying several hundred miles of track the Eastern Massachusetts Street Railway Co. has used several methods of welding joints: the Lorian bar, which is spot welded by an electric current; the Thermit, which is a chemical reaction designed to fuse the rail ends together; and the so-called seam weld by using either the carbon arc or the metallic arc to place a metal bead along the top and bottom of plates at the rail ends. All of these methods are good, according to Mr. F. B. Walker, chief engineer of the company, if properly applied. None of them are perfect, but for the past two seasons he has employed the metallic electrode arc method most successfully, and for the moment believes it to be the best for the work. So far he has never found a failure. There have been breakages of plates and rails, but these types of breaks do not total 2 per cent. of the total joints welded and are probably due to temperature stresses or defective rails or plates. Expansion joints are put in about 750ft. apart on open tracks, but no expansion joints are needed or ever put in on paved track, as it can be readily shown that if the rail is held in line by the pavement, temperature changes produce stresses which are well below the elastic limit of the rail.

A frequent question in the lighting of refrigeration rooms, such as meat coolers, cold storage warehouses, &c., is the relative heating effect of vacuum and gas-filled lamps within such interiors. The fact that the immediate vicinity of the gas-filled lamp is comparatively hot, states the *Journal* of the American Institute of Electrical Engineers, gives rise to the erroneous assumption that a gas-filled lamp will heat the interior of a cold room to a greater extent than will a vacuum lamp of equal candle-power. A refrigerator room, from its very nature, is usually constructed in such a manner that its walls are extremely well insulated to prevent the passage of heat and light through them. Thus the entire amount of heat and light energy emitted by an incandescent lamp in such a room is eventually absorbed by the walls of the room and taken up by the cooling system. A vacuum and a gas-filled lamp of equal consumption emit equal total amounts of energy (heat and light combined). Hence the effect of each of these lamps on the cooling system is exactly the same. A 100-watt gas-filled lamp completely enclosed in a refrigerator so that all of its energy is applied to melting ice, will melt 57 lb. of ice at 0 deg. Cent. in twenty-four hours.

In concluding some notes on "Inclusions in Aluminium-alloy Sand Castings," in a technical paper of the American Bureau of Mines, Mr. R. J. Anderson urges that all small foundry scrap should be forked before charging, and floor sweepings should be sieved. Some of the foreign material which is inadvertently charged into the furnace may be removed by skimming and fluxing, but it is not safe to rely upon these practices to overcome the evils of a dirty charge. If the admixed foreign matter is readily wetted by aluminium, and is of nearly the same density as the metal, or both, it will remain in the liquid metal and ultimately appear in the castings. In crucible melting, particularly where the crucibles are old, badly cracked, and weak, pieces of the crucible may fall or be knocked into the metal and carried into the castings. Where plumbago crucibles are used for pouring with any kind of melting practice, pieces of the crucible may be found in the castings, hence crucibles should not be used too long or until they become cracked and readily friable. No core sand should be left in defective castings that are re-melted, as the hard, fine, silica particles may give rise to small hard spots. Foreign non-metallic hard spots can be largely eliminated, provided sufficient attention is given to the charging practice.

Miscellanea.

It is proposed to drill for petroleum in the parishes of West Bilney and Pentney in Norfolk.

The Electricity Commissioners, in view of the impending General Election, have decided to postpone the North Wales and Chester Electricity inquiry until Tuesday, November 21st. The time and place of the inquiry will remain unaltered—Town Hall, Llandudno, at 10.30.

On November 8th, a meeting of the Institution of Automobile Engineers will be held, at which Major F. Strickland will uphold the low-compression moderate-speed engine against Mr. H. R. Ricardo, who will support the high-compression high-speed engine, in the form of a debate.

Some experiments which are being carried out at Fort Collins, Colorado, on the rate of evaporation from a free water surface have demonstrated the fact that under still air conditions maximum losses occur during the early morning hours, a phenomenon contrary to what is generally expected to occur.

The largest casting so far turned out in South Africa, weighing 50,000 lb., was recently made, according to the *Ironmonger*, at Salt River Works. The operation proved a complete success, and when the casting was dug up it was found to be without a flaw. It is intended for an anvil block for a 3-ton hammer.

Development of the bituminous sand deposits of Alberta for the manufacture of oils may lie in the future, according to Dr. K. A. Clark, of the research department of the University of Alberta, but the use of the product for the making of roads is not so problematical. It is likely that some method of economical use will be soon found.

It is announced that experiments are to be made in the Paris district in the flying of a pilotless aeroplane, which will be controlled by wireless. The aeroplane will be sent up with a pilot, who will watch the operation of the wireless waves on the controls as the waves are transmitted from the earth, but the pilot will only intervene in the event of the machine failing to respond.

It is reported from Pretoria that the Union Government has confirmed the contract with the Imperial Cold Storage Company for the erection of a cold storage establishment in South-West Africa. The Government will grant a free site for the works, concede an exclusive licence during a period of fifteen years for the export of dead meat to markets outside the Union, and similarly a licence regarding live stock exported overseas during a period of three years, and other facilities. The company undertakes to erect storage capable of dealing with 150 head of cattle and 300 sheep per working day and to carry on subsidiary undertakings.

A new tool steel of the tungsten-chromium-cobalt class has recently been put on the market in America, and it is stated that remarkable speeds and endurance-cutting tests on cast iron and alloy steels have been achieved. The metal is non-magnetic, contains no ferrous compounds, but has the appearance of steel. It is melted in electric furnaces and cast into steel moulds in the form of tool bits, twist drills, reamers, insertions for built-up milling cutters, &c. It is impossible to forge or anneal the metal, and the only way to alter the shape is by grinding. The metal is very dense, and is stated to be free from blowholes and internal strains, with a high-resistance factor that makes it particularly adaptable to cutting metals. It can be given large rake and clearance angles.

In an article on the effect of the Versailles Treaty on the Iron and Steel industry of Europe, the *Iron Trade Review* points out that the *rôle* played by war scrap in maintaining Germany's pig iron production during the past two years has been given too little consideration in outside countries. When the war ended, tremendous tonnages of scrap were made available for German blast-furnaces, and these reserves were greatly augmented by the destruction of war material of all classes under the disarmament clauses of the Peace Treaty. To avoid using high-priced imported ores, some German blast-furnaces up to the beginning of this year were charging as much as half scrap. The end of the war-time scrap pile is now in sight. As Hugo Stinnes said recently, Germany must again turn to iron ore as raw material for pig iron manufacture, with unsatisfactory results from the standpoint of the cost of production. For a brief period last year, owing to the scrap situation just described, she again led the world in the iron and steel export trade, with maximum exports of 242,300 tons in October, 1921. Since this, as the scrap pile has been used up, Germany's exports have diminished to an average of 200,000 tons per month so far this year.

The first of a series of lectures on "Industrial Welfare," which have been organised by the College of Technology in the University of Manchester, was delivered on Monday, October 23rd, by Mr. Robert R. Hyde, director of the Industrial Welfare Society. Mr. Hyde first traced the history of this growing movement from an incident which occurred during the latter part of 1915, when Mr. Lloyd George, then Minister of Munitions, visiting a French factory, was struck by the painful collapse of a girl worker. Mr. Lloyd George asked why the girl had not been excused from work, and was informed that the foreman concerned was young, and ignorant of the circumstances. On his return to London, the then Minister of Munitions called in Mr. B. Seebohm Rowntree to establish the welfare department of the Ministry of Munitions, where he was immediately joined by Mr. Hyde—who, it may be said, had spent the greater part of his life in an attempt to alleviate the lot of the boys and young men in one of the poorest districts of London. The problems which had to be faced were appalling. Three to four million boys were employed in the national factories and controlled establishments alone. In 1918, Mr. Hyde, convinced that the well-being of the workers was a matter for industry itself and not the State, resigned his official appointment, and with the help of several far-seeing employers founded the Industrial Welfare Society, which now includes among its members the largest firms in the country. It was difficult to compute the number of firms where welfare was in operation.

TYPICAL VIEWS OF A CENTRAL CHINA ROAD

(*For description see page 461*)

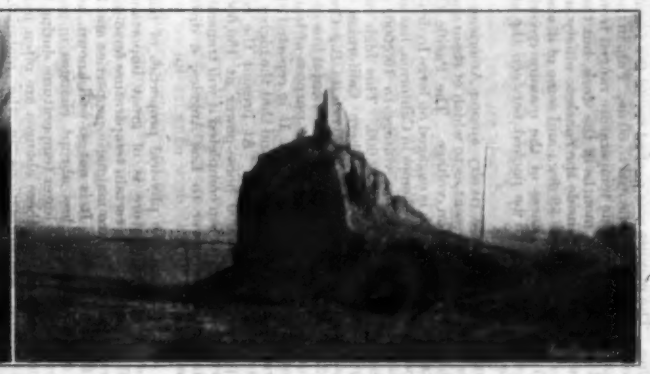
BRIDGE OVER PARTLY FROZEN SANG KAN HO

TRACK THROUGH LOESS, NEAR TA TUNG

BARROW ON EARTH ROAD IN SHANTUNG

ROAD THROUGH SINCHOW BETWEEN TATUNG AND TAIYUAN

TEMPLE ON PILLAR OF LOESS



TEMPLE ON LOESS PILLAR NEAR KUOHSIEN

VIEWS IN THE HANHOW PASS BETWEEN TAIYUAN AND PINGYAN, THE HIGHEST POINT, ON LEFT, IS ABOUT 10,000 FEET ABOVE SEA LEVEL

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DEATH.

On October 30th, Walter Douglas Seaton, A.M. Inst. C.E., the only son of the late George Seaton, formerly of Gothenburg and the East London Waterworks Company, aged 66.

THE ENGINEER.

NOVEMBER 3, 1922.

The New Battleships.

The fact that the Admiralty, as we were able to announce last week, has invited tenders for the construction of the hulls and machinery of the two battleships which this country is empowered to build under the terms of the Naval Limitation Treaty, should finally dispose of the rumours which have been persistently circulating for many months, to the effect that the vessels in question were not to be proceeded with, their construction having been deemed inadvisable both for economical and technical reasons. Despite what has been said to the contrary, the Admiralty, we are given to understand, has never had the least intention of abandoning these ships, which it holds to be essential to the maintenance of that one-Power standard upon which its policy is based, a standard that involves keeping the Navy at sufficient strength to ensure the safety of the British Empire and its sea communications as against any one other naval Power. Nor will anyone who surveys the naval situation as it exists to-day deny the necessity of building the two new capital ships if the Admiralty is right in continuing to regard vessels of this type as the supreme embodiment of offensive power at sea. On that controversial question we have more than once expressed our views, and need only add here that the balance of evidence, theoretical as well as practical, is such as to vindicate the continued primacy of the great ship, for some years at all events; and it is the business of our naval authorities to legislate for the requirements of the discernible future, not for what may be needed at some period beyond the range of human prevision. We think, therefore, that the nation at large, notwithstanding its fervent desire for retrenchment, will approve the official decision with respect to the new battleships, for it is by no means prepared to sacrifice that measure of sea power which the Admiralty declares to be the minimum compatible with security for the country and the Empire. There could be no greater error than to assume that the British people have become indifferent to their Navy or to the interests which the Navy safeguards.

Owing to the many firms which have been invited to tender, bidding for the hull and machinery contracts promises to be unusually keen. The shipbuilding and affiliated industries are still suffering from an unprecedented shortage of work, and because of this circumstance the award of the contracts is awaited with intense interest in the districts affected. For the same reason, the Labour element has for once abandoned its traditional antagonism to armaments and is using its influence to procure the laying-down of the ships at the earliest possible date. The stake which the wage-earning community has in the work is, indeed, no inconsiderable one. Speaking in the Upper House on July 11th, Lord Lee, the late First Lord of the Admiralty, said that the two ships at current prices would cost £6,500,000 apiece, or, including all accessories, reserves, stores, &c., both afloat and ashore, something like £8,000,000 apiece. Of this total of £16,000,000, at least £10,000,000 will be paid out in wages over a period of about two and a-half years, so that the allocation of even one ship will be an immense boon to the wage-earners of the district that is fortunate enough to secure it. The Royal Dockyards are definitely out of the running so far as these two ships are concerned. Neither Portsmouth nor Devonport could undertake the building of a vessel of 35,000 tons with its present facilities, and to enlarge the slips sufficiently for that purpose would entail an expenditure which the Admiralty regards as inadmissible at the present juncture. It would, moreover, involve a delay of nearly two years, whereas the reinforcement of our Navy by modern capital ships is already overdue, and cannot be longer deferred. These were the main considerations which led the Admiralty to put all the four battle-cruisers out to tender last year, and they apply with equal force now that the original programme has been reduced by the Limitation Treaty to two ships of smaller dimensions. The largest men-of-war hitherto built at the Royal yards were those of the "Queen Elizabeth" class, displacing 27,500 tons, and having a length of 644ft. overall. The new battleships are to be of 35,000 tons and their length will not be far short of 700ft. Their beam, according to our information, will be 106ft., which will make them the broadest warships so far designed by any country, though it is only 9¼in. more than that of the Hood. This remarkable increase of breadth, as compared with ships of the pre-war area is, of course, due in the main to the development of structural protection against underwater explosion, and especially to that ingenious and highly effective device known as the bulge. When the plans of the Hood were being prepared, it was realised that her completion would raise the question of dock accommodation in an acute form, as the ship would be unable to dock at any naval yard in this country, with the exception of Rosyth. The four "modified Hoods" of last year's programme, since cancelled, were to have been considerably larger—47,000 tons was the displacement, as mentioned at the Washington Conference—though the Admiralty stated that the dimensions had been kept within limits which would obviate the necessity of any larger docks being provided other than those already existing. Still, had we been compelled to go on building vessels of that great size, the provision of additional docks capable of accommodating them would soon have become imperative, and we have therefore to thank the Limitation Treaty for sparing us heavy expenditure, quite apart from that involved in unrestricted battleship competition. As things are, our present docking resources will doubtless prove adequate for a long time to come.

Although their armament has not yet been disclosed, there is every reason for believing that the new ships will mount guns of the same calibre as those with which the "modified Hoods" were to have been armed, viz., 16in. It is also possible that, in spite of the greatly reduced displacement, they will carry the same number of these weapons. The much lower speed which has obviously been accepted for vessels re-designed as battleships proper instead of battle-cruisers will mean a great saving in machinery weights, and the margin thus obtained is most likely to be employed in keeping the offensive and defensive attributes as far as possible up to the original standard. As, however, only two ships are to be built in place of four, there will be a corresponding reduction in the value of the armament contracts issued in connection with the building programme. It should be noted, also, that the guns and mountings for the cancelled battle-cruisers, part of which were ordered twelve months ago, will be used for the new battleships. The Vote for "Armaments" in last year's Navy Estimates stood at £6,726,000, and it was then proposed to ask for £6,683,000 under the same Vote in the Estimates for the current financial year. For naval guns, the cost of manufacture alone was estimated at £1,148,550, of which sum £810,000 was for the guns of the "modified Hoods," and

projectiles for those guns were to be manufactured at a cost of £800,000. All such items of expenditure have, of course, been reduced in consequence of the deletion of two ships. It is as well to emphasise these facts, lest the beneficial influence of the impending warship contracts on the industrial situation should be exaggerated. That they will, in any case, be most welcome, goes without saying, but it will take a good deal more than the ordering of two 35,000-ton battleships to reanimate the shipbuilding and engineering industries of this country, which have suffered so cruelly under the abnormal economic conditions of the post-war period. From their point of view, the Washington Limitation Treaty has not been an unmixed blessing, for it not only reduced the amount of naval tonnage immediately in contemplation from about 190,000 tons to a mere 70,000 tons, but destroyed all prospect of further heavy contracts of this kind for a term of many years. On the other hand, prominent representatives of the industries named have been foremost in admitting that naval armament limitation will ultimately exert a healthful influence on the economic life of the nation, however unpromising its immediate effects may seem.

Railway Labour.

THE brightest feature of the British railway situation is found in the happy relations between the companies and their men. Never, during the hundred years of railways, has this aspect of the railway position been so good. There is, at present, a noticeable *esprit de corps* among the men, a greater desire to give a day's work for a day's pay, both in the operating and the manufacturing and repairing branches, that is beneficial to men and masters, and consequently therefore to the railway proprietors and railway users. We will not allow ourselves to think that a fear of the effects on labour of railway grouping is the cause of this change; though it must be recognised that one consequence of the big amalgamations now being made may be considerable reductions in the number of men employed. We prefer to believe, and will almost go as far as to affirm, that the attitude of the men is the result of the unions having been recognised and of the men themselves having been given a greater interest in the operation of the railways. This interest is not as great as Sir Eric Geddes intended when, in the outline of his proposals, made public towards the end of June, 1920, he laid down that the boards of management should include representatives of the employees, elected from and by the workers. Subsequent discussions, directly between the companies and the men's unions, led to clauses being agreed upon for inclusion in the Railways Bill—now the Railways Act, 1921—for the recognition of the three railway unions, the continuance of the Central and National Wages Boards, and for the establishment of Whitley Councils. The Whitley Councils cover local departmental committees at stations and depôts, sectional councils on each railway representing the various grades, and a railway council for each railway. Above the railway councils is the Central Wages Board, and the final court is the National Wages Board. Both the companies and the men have expressed their determination to give the conferences a fair trial, and, judging by what has happened since the councils were inaugurated in April, they would seem to be doing all the good that was expected of them.

This contentment is in marked contrast to the state of affairs which existed when Mr. Lloyd George entered office for the first time, now nearly seventeen years ago. One of his earliest acts, after being appointed President of the Board of Trade, was to establish the Railway Employment Safety Appliances Committee. There was considerable unrest in the railway world then. Whilst the men's hours had been brought within more reasonable limits, their pay, as all now admit, was very poor. They prepared an "all grades" programme, but as they persisted in it being presented through the unions it was not listened to. The North-Eastern had accepted "recognition," but its relations with the men were no more friendly than were those of its neighbours. In the autumn of 1907 there was every probability of a strike, but it was averted by Mr. Lloyd George arranging for the establishment of conciliation boards, all the members of which were to be railway servants. The Prime Minister's attitude towards the railway companies was clearly indicated on the occasion of the Shrewsbury accident of October 15th, 1907. He ordered Colonel Yorke at once to open his inquiry, and he himself went to the meeting, accompanied by Mr. Cunliffe, the solicitor to the Board of Trade, and Mr. G. R. (now Lord) Askwith, the head of the Railway Department. That was an unprecedented event and one that, as we remarked at the time, was, in view of the state of public opinion at the time, scarcely discreet, whilst his frequent interruptions of the proceedings could not but affect "the efficiency of the inquiry and undermine the confidence—so well deserved—in Colonel Yorke and his colleagues." Before Mr. Lloyd George left the Board of Trade in 1908, to succeed Mr. Asquith as Chancellor of the Exchequer, he had learnt some of the difficulties of the companies and had brought about the appointment of the Board of Trade Railway Conference in April, 1908, by Mr. Winston Churchill. Mr. George was the principal intermediary between the companies and the men when the general railway strike of August, 1911, was settled by the Government promising legislation and that the cost of any concessions made to the men should be passed on by the companies to the traders. The events that led up to that deplorable strike were due to his hastily conceived conciliation scheme, part of which provided that any award by an arbitrator should hold good for a certain time. The consequence was that when the men went the "whole hog" and put forward their "all grades" programme, no item therein, having once had judgment passed upon it, could again be brought forward. The companies' attitude was quite correct, as they were acting in accordance with a scheme that was none of their initiation. The strike led to the companies meeting the men's leaders on the new conciliation boards, and when the happier results that have been brought about are considered, one cannot but smile at the fears railway directors and officers had of "recognition." All this, although only nine years old, now appears rather ancient history, but we think it advisable to mention it as providing encouragement for the hope that as peace has been brought to the railway world, so it may come to other industries.

It is to be hoped that, under grouping, every effort will be made to retain the present close relationships between the companies and their men, but difficulties will have to be faced, when, for example, one system embraces the whole of the railways between London and Bristol on the South and Wick on the North, and another those between King's Cross and Elgin. It is practically impossible for one man to be in close touch with all the different districts in such a length of line, and to be well acquainted with the peculiarities of the various labour fields. There are many varieties in Scotland alone, and the Scottish character differs from that of the men in Lancashire and Yorkshire, which, again, differs from that to be found in English agricultural areas, the Potteries and the Black Country. No hard-and-fast treatment can be applied to all these classes, but with one vast system such may be attempted, and, if it is, the present happy relations will soon be broken. The Central and National Wages Boards have done, and will, we expect, continue to do, good work, but the importance of local relations must not be minimised. There are, for instance, proposals now under consideration for abolishing the guaranteed day's pay if called out, for reducing the higher rate of pay for night duty between 10 p.m. and 4 a.m., and for extending the day's mileage for enginemen from 120 to 150, and such modifications in the eight hours' day as shall ensure that eight hours' pay mean eight hours' work. The men's representatives that are dealing with these questions are in close contact with their unions, and grouping will not affect that relation. But when the twenty or thirty active companies are reduced to four, their delegates may be less responsive to the local needs. We trust, therefore, that in the details of each grouping scheme provision will be made for the retention of some of the local officers who know the men and the labour market, so that there shall, as regards railway service, be continuity of a policy which is bearing such good results.

Institution of Mechanical Engineers.

SUPERCHARGING FOR AERO-ENGINES.

THE Institution of Mechanical Engineers met at Storey's Gate on Friday, the 27th, to discuss the paper on "The Use of the Turbo-compressor for Attaining the Greatest Possible Speeds in Aviation," which was presented at the Paris meeting* by Professeur A. Rateau, but which was not then discussed. Dr. Hele-Shaw, the President, took the chair, and as Professor Rateau was unable to be present, on account of illness, Dr. Hele-Shaw gave an outline of the paper, a portion of which we reprint on page 476.

Aviation, he pointed out, was of little commercial value except in so far as it provided a very rapid means of communication, and thus, leaving aside military considerations, the chief aim of the aero-engineer was speed. By going to high altitudes it would be possible to increase the present working speed of some 100 miles per hour up to, say, 250 miles per hour, but when the engine was taken to those heights it became necessary to use a compressor for introducing its combustible charge. Otherwise the engine did not receive sufficient oxygen and could not develop the necessary power. Dr. Hele-Shaw illustrated the state of affairs by pointing out how a motor car which, at sea level, had ample power for all services, could hardly surmount Hospital Hill, Johannesburg, where the barometer stood at 24in. The use of oxygen during the recent attempt to climb Mount Everest was another example.

In the paper the author makes the statement that "the aeroplane is the only vehicle in which the resistance to travel is independent of the speed." These words, the President explained, really needed qualifying, as they did not properly put forward what the author had in mind. He really meant that the aeroplane was the only vehicle in which it was possible to increase the speed without increasing the engine power, which could be effected by flying at an appropriate altitude.

Comparisons were given in the paper, which showed that it would be absurd to attempt, on land or water, to attain speeds which could easily be maintained in the air. Thus the resistance of a large Transatlantic liner, steaming at 25 miles per hour, was 6.0 kilos. per ton, that of a railway train going 62.5 miles per hour was 10 kilos. per ton, and for a motor car travelling at 62.5 miles per hour the resistance was as high as 70 kilos. per ton. If, however, the speed of all these vehicles could be pushed up to 250 miles per hour, it appeared from extrapolation from the formula for resistance, that their resistances would rise to the enormous figures of 600, 150, and 500 kilos. per ton respectively. The paper went on to show how speeds of that order could be attained in the air with a resistance as low as 120 kilos. per ton, and gave a brief description of the turbo-compressor devised by the author for supercharging the engine and thus helping it to develop full power at high altitudes. The turbine utilised the exhaust gases of the main engine as its motive fluid and drove a centrifugal blower, which compressed the rarefied atmosphere to normal pressure. The machine ran at a speed of from 25,000 to 30,000 revolutions per minute, and was a very ingenious piece of engineering.

Professor Bairstow, who at the invitation of the President opened the discussion, said that he first became interested in flying at high altitudes in 1915, when it was necessary to find something to counter the raiding Fokkers. It was then suggested that our engines might be supercharged by means of centrifugal fans, or that they might be supplied with extra oxygen carried in the liquid form. The latter expedient, however, was found unsatisfactory, as it raised the temperature of explosion and resulted in burnt valves. Professor Rateau's compressor was a very ingenious example of the centrifugal compressor, and possessed the great advantage that it had no rigid connection with the main engine. It thus was not subject to shock caused by variations in the angular speed of the engine caused by misfires.

Professor Bairstow then went on to discuss the merits of flying at high altitudes, looked at from the commercial point of view, and pointed out that people will only pay up to a certain amount for extra speed. In other words, speed, if its cost went beyond a reasonable margin, had no commercial value. He exhibited some curves which showed that Professor Rateau's contention that the resistance of an aeroplane is independent of the speed only holds good over a narrow range, and must have been based on a constant angle of incidence. As a matter of fact, the horse-power varied as the cube of the speed and the resistance as the square of the speed. Another curve demonstrated the fact that the rate of climbing falls off with increased height.

The whole subject really resolved itself into adapting the machine to deal with air of varying densities, and Professor Rateau's was not the only means of doing so. There was, for instance, the new Handley Page slotted wing. In any case it was always necessary to fly at such a speed that the machine was supported, and the conditions could be represented by the equation

$$W = k_L \rho S V^2$$

where W = weight, k_L = a coefficient, ρ = the density of the air, S = the wing area, and V = the velocity. All these factors, said the speaker, were settled except k_L, which might vary, but for which there was only one best value, and that might be determined by laboratory trials.

Transposing the equation became

$$k_L = \frac{W}{S \rho V^2}$$

and inserting w, or weight per unit area, in the

* See THE ENGINEER, June 23rd, page 686.

place of W divided by S the equation

$$k_1 = w \rho V^2$$

was obtained; (w ranges from 1 lb. to 1½ lb. per square foot for gliders, through 7 lb. for light scouts, and might be as high as 13 lb. per square foot at the beginning of a long bombing raid.)

Thus it would be seen that, as k_1 could not be increased beyond a certain definite amount, there was always a definite speed below which the machine in question could not fly. By keeping the product of the atmospheric density and the square of the speed constant, and by flying at the best angle of incidence, it would be possible to fly at any desired height. On the other hand, the resistance,

$$R = k_D \rho S V^2,$$

and remained so at all heights.

Thus it developed that the work done on a journey by air was equal to the product of the resistance and distance, irrespective of the speed at which it was carried out. Thus it came about that the consumption of petrol was irrespective of the speed.

A flying machine following M. Rateau's policy would spend about an hour in climbing to its flying height and another hour in coming down again, so it was obvious that the scheme would have no merit for short journeys, such as that between London and Paris; but for long distances it appeared at first sight to be advantageous. It had, however, been found from experience that about three hours of continuous flying was the limit of endurance for the average pilot.

Professor Bairstow did not think that it was necessary to provide the colossal speeds suggested in the paper to make aerial communication of commercial importance, as the aeroplane was already about twice as fast, while in the air, as is a railway train. If flying could be continued during the night, as appeared to be probable in the near future, the aeroplane would then be able completely to outstrip the railway train. On the other hand, for military purposes, ability to rise to greater heights than enemies was a valuable characteristic, and for such services the supercharger might be developed.

Mr. W. Reavell commented on the difficulty of the task which Professor Rateau had set himself in compressing a large volume of air to a comparatively high degree in a machine which must necessarily be light, and pointed out the importance, in such a consideration, of the influence of peripheral speed on the weight. In ordinary practice, with fair-sized machines, it was generally considered that a peripheral speed of 1000ft. per second was the limit imposed by the physical characteristics of the best materials metallurgists had offered; but Professor Rateau had increased this limit to 12,500ft. per second, and had even driven his machine at a peripheral speed of 22,000ft. per second. In this way he had succeeded in increasing the compression ratio in a single stage up to 2 to 1, and by working at 53,000 revolutions per minute got a ratio as high as 4½ to 1. It was, said Mr. Reavell, a great triumph for mechanical engineering, but hardly the sort of thing for application on a large commercial scale.

The author had shown that, for the conditions he was considering, the energy in the exhaust from the main engine was more than ample for the purpose, and some evidence on that fact was given by the design of the blower, which had no refinements like guide vanes. It should be borne in mind, however, that the power required to compress the air, besides the size of the compressor itself, would increase greatly as the machine went up. Mr. Reavell here drew a diagram on the board which clearly demonstrated his idea, and which showed the great development of the area of the power curve as the ratio of compression was increased. He marvelled at the possibility of working a machine in which two adjacent parts were at such widely different temperatures, as the turbine wheel using the exhaust gases and the blower receiving air at about zero temperature. He wondered if the turbo-compressor could be relied upon to run continuously for long periods, and also wondered in what condition it would finish if it did succeed in running through. From that point of view it might be advantageous to cool the exhaust gases somewhat on their way to the turbine, as it appeared that they could afford such a loss of energy and still be sufficient for the author's purpose. Professor Rateau had, he thought, fallen into an error in stating that it would be necessary to use a change-speed gear-box, such as that fitted on a motor car, in order to get a compressor to give a varying volume of output when driven by a constant-speed motor. There were in existence, said Mr. Reavell, compressors which gave varying volumes at a constant speed.

Mr. A. E. L. Chorlton said that the subject interested him chiefly on account of the fact that Professor Rateau had, in effect, produced a compound internal combustion engine—by taking the exhaust gases and employing them in the turbine. The exhaust from an internal combustion engine normally took place at a pressure of about 40 lb. per square inch, and it certainly seemed best to recover the energy in the gases by passing them through a turbine. Unfortunately, however, the turbine must run very fast, and it was impracticable to connect it with the main crank shaft. It might, nevertheless, be possible to use the turbine for driving auxiliaries. Mr. Chorlton gave a brief history of supercharging, which was first tried some thirty years ago, in an effort to reduce combustion temperatures. The early experimenters used the idle side of the main piston for air pumping purposes, after which rotary blowers were used, and it was noteworthy that the latter policy was now being adopted on the Continent. The next step in evolution was the use of a fan. Was it not possible that in future an ejector, or, rather, injector, might be used? It would have no moving parts to go wrong. The design of the Rateau blower rotor was, he presumed, inspired by considerations of strength, as it did not appear, as had been suggested by Mr. Reavell, that it could be very efficient.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE STUDENT IN THE FACTORY.

SIR,—I read with considerable interest the article on "The Student in the Factory," in your issue of October 20th. While I feel I must agree with the views expressed therein, I should like to put before you my views as a student.

The average University student leaves school at 19, and then spends three years in a University. Three years at Cambridge cost about £300 a year. He then proceeds to another three years' apprenticeship, where his wages are about half his living expenses. By this time he is 25, and has spent something like £1000 on his education. He then looks about for a job, and finds—if he is lucky enough to find a job at all—that the salary of the post for which his kind of training is supposed to have fitted him is £200 a year.

It is usually said, I am well aware, that this is only his starting salary, and that if he has ability he will soon rise. But firms are extraordinarily reluctant to give any indications as to what prospects are available, and the student begins to wonder if he can use his knowledge in some more certain and lucrative direction, *e.g.*, teaching in a school or University. I realise that engineering is by no means the best paid profession nowadays, and that those who enter it cannot expect at the best to be more than comfortably off; but surely one ought to be able to look forward to something better than £200 a year at 25 years of age, with a University training behind one.

Again, for the most part, a University student studies the theoretical side of his subject, and not unnaturally hopes to turn his theoretical knowledge to some account when he begins to earn his living. This means that he will probably take up design or research—the two worst-paid branches of the profession. I speak as a student, and cannot claim to have any great knowledge of the situation; but it does seem to me that the man with the theoretical training—even with a "first class"—stands very little, if any, better chance than the man who has never been to a University; and in view of the expenditure of time and money that a University education involves, this does not seem right.

Cambridge, October 20th. STUDENT.

SIR,—As one of the graduates of the north-west, I think your leader of the 20th inst. calls for some explanation of the other point of view.

You state "that there is not that absorbing devotion to engineering that inspired men in days gone by," and that "youths carry on well enough through the technical schools, where they find the ladder of learning made easy; they jib at the shops." Considering the fact that an honours graduate is compelled to study until he is 18 years of age at school, and after that has at least three years of a course which is as exhausting and "gruelling" as any mental work can be; considering the fact that he finishes with absolutely no prospect of being able to support himself—I think your very vague and general statements show a complete lack of foundation, except perhaps the reference to the shops, with which I propose to deal later.

Those words appear to apply to young men who have just finished a technical course as a whole. Likewise, the reference later that "they need advice more than born engineers." I should like to ask exactly what course a "born" engineer would pursue if it happened that he found himself at a public school with prospects of scholarships and scholastic successes carrying him through to the highest technical training this country can give? Or is it assumed that nowadays we have no "born" engineers—in other words, that education and scientific treatment of the basic principles have resulted in deterioration of a country's brain power?

It is an aim and a duty of any progressive country to develop its science, and it either is, or should be, a fact that a man with outstanding ability should be able to take advantage of such facilities. I believe that in England to-day the youth with ability has an opportunity of finishing his technical training in a University, and it is only logical to take it for granted therefore that if such "born" engineers exist to-day, some at least will be numbered among our graduates; and for the remainder who managed to obtain a high place at Universities of standing, Mr. Day's first quality of industry could hardly be denied by any man who has the right to give an opinion.

Your assertion of "an exaggerated view of the importance of their scholastic education and a disinclination to understand engineering problems from the manufacturer's standpoint," is, I think, a general statement that may do serious harm. In some cases I know it is true—but in general it certainly is not true. To-day, as for the past four years, I know men personally who have come out at the top of one of our most respected northern Universities who would do anything for the chance to be able to earn a wage sufficient only for the barest necessities, and to give them a chance to observe and learn the practical side. And they have found in nearly every case one of three things:—First, that there were opportunities in some cases for spending two or three years in a works with no remuneration whatever, if they were to have any opportunity of seeing more than one type of job, of learning the possibilities of more than one machine; secondly, from some kinder-hearted firms an arranged course of two or three years, with a remuneration of 20s. to 30s. a week; thirdly, no engineering practice whatever, because they were only regarded as a nuisance—and this a common reply. There were two other alternatives for the lucky few—the one of paying handsomely for the period of shop experience, and the other due to the foresight of such rare firms as Metropolitan-Vickers.

To the many unfortunates who needs must live by their own labours, it is poor consolation "not to feel impatient if there appears to be little call for the theoretical knowledge they have with difficulty acquired." Prospects like these are sufficient in themselves to debar most men from entering mechanical engineering—at a time when our rivals are making every possible use of scientific development.

English employers as a whole may thank their conservatism for the way America, Switzerland and Germany have forged ahead, not only since the artificial conditions of to-day came into being, but even in 1914. Here are countries where a man who has reached the limit of technical training by merit of his own ability is not regarded as a "swelled" headed "seeker of a paying profession." And it would be a bigger help to our industry than most people realise if employers would hold out a helping hand to the worthiest of these men, would realise that they are eager and willing to learn to be of some practical use, would take it as a fact that even the "born" engineer of bygone days could not live on air when he reached the age of 21. Until this happens, it will be an utter impossibility for any young man without a deep-pocketed parent to complete what is undoubtedly an ideal programme.

Obviously, while the present chilly welcome is extended to our outgoing graduates the industry is the loser. In particular, it might at least be remembered that most of the graduates of the present day who have just entered the practical world of engineering have given three or four of the most vital years of their lives in the Army, and have come back and won through in spite of this—a handicap that experience alone can measure. And now at the age of 24 or 25, they are asked to live on patience until a day when they have forgotten all they ever knew, until all the enthusiasm and energy of youth have given place to the uncreative placidity that inevitably overcomes those who get into a rut. Luckily, there are a few firms in the country who can see further ahead; for the rest—well, there are countries where a man can make good, given youth, brains and initiative.

Manchester, October 25th. ONE OF THEM.

[If our correspondent will do us the justice to read our article as a whole, he will perceive that we were drawing a distinction between those who are "born engineers" and those who take up engineering only because they think it is a "paying profession." We certainly did not say, as our correspondent's quotations, standing alone, would seem to imply, that in these days there are no "born engineers"; there are, thank goodness, plenty of them, and we trust we may understand our correspondent's pseudonym to mean that he is "one of them" and not one of the other class.—ED. THE E.]

ENERGY IN THE ATMOSPHERE.

SIR,—The following calculation in reference to the above may perhaps be of some interest.

In 1 cubic foot of atmospheric air there is stored up an amount of energy equal to $144 \times 14.7 / 1.408 - 1 = 5188$ foot-pounds —1.408 = ratio between specific heats of air when maintained at a constant volume and when maintained at a constant pressure—this amount being the energy which would be given out by the 1 cubic foot of air were it allowed to expand into absolute vacuum.

Taking the mean radius of the earth to be 3963 miles, the total quantity of atmospheric air on the surface to a depth of 1ft. would be—

$$4.189 [(3963 \times 5281)^3 - (3963 \times 5280)^3]$$
$$= 4.189 \times 3963^3 [5281^3 - 5280^3]$$
$$= 2.607 \times 10^{11} \times 8.365 \times 10^7 = 2.18 \times 10^{19} \text{ cu. ft.}$$

and the total energy in this would be—

$$2.18 \times 10^{19} \times 5188 = 1.13 \times 10^{23} \text{ foot-pounds.}$$

Now, 1,000,000 horse-power = $1{,}000{,}000 \times 33{,}000 \times 60 \times 24 \times 365 = 1.73 \times 10^{16}$ foot-pounds per year. Therefore—$1.13 \times 10^{23} / 1.73 \times 10^{16} = .653 \times 10^7 = 6{,}530{,}000$ years; *i.e.*, the energy in the 1ft. layer of atmosphere would give out 1,000,000 horse-power for 6,530,000 years!

November 1st. H. R. KEMPE.

LOCAL ELECTRICITY SUPPLY *v.* BULK SUPPLY.

SIR,—I am pleased to see one of your correspondents drawing attention to the most recent developments in steam engine practice, though "this most recent development" has been in existence many a year.

Power users are somewhat slow to take up a new development in this country, partly because heretofore the cost of coal was so low. Now things are changed. The cost of power appears in the balance sheets of most manufacturing concerns as a considerable lump sum, and in certain instances represents a considerable bigger percentage of the turnover than it did before the war. It is more than ever necessary for steam power users to look to their power and heating costs, and for engineers to show them how their costs can be kept down by their up-to-date plant.

I should like to use "W. S.'s" method of comparing costs between a compound engine and a heat extraction engine in a woollen mill such as exists in this district. One example that we recently inquired into was a mill having a 350 indicated horse-power engine. We were informed that half the steam was used in the engine, half for process work in the mill. The following figures were given:—Tons of coal per year, 2380; hours worked per year, approximately, 4955; indicated horse-power of engine, 350. This works out at about 13 lb. of steam per indicated horse-power per hour for power purposes.

If the owners were to install an engine in which the steam for process work did work in the high-pressure cylinder and the remainder of the power was supplied by surplus steam doing work in the high-pressure cylinder and being fully expanded in the low-pressure cylinder, we would get the following results:—When calculating that approximately 4550 lb. of steam are being used in process work, if this is first expanded in a high-pressure cylinder the initial steam pressure being 160 lb. and the exhaust pressure being 30 lb., we can obtain 1 indicated horse-power for each 34 lb. of steam per hour supplied. Therefore, with 4550 lb. of steam, we are able to obtain 134 indicated horse-power, leaving 216 indicated horse-power to be generated by the make-up steam which will be expanded to, say, 26in. vacuum.

Working back from the coal figures given, we have 2380 tons of coal. Say 20 tons of this is used for banking on week-ends, leaving 2360 tons for power and heat. Of this, 1180 tons per year are used for heating, which now produces 134 indicated horse-power, the remaining power, namely, 216 horse-power,

requiring 1180 × 216 ÷ 350 = 727 tons of coal per year. Saving in coal is thus 1180 – 727 = 453 tons per year.

This is a considerable saving in itself, but we have assumed that the pressure for the heating steam is required at 30 lb. per square inch above atmosphere. With some rearrangement for pipes and possibly air pumps at the end of the system, it may be possible to reduce this pressure in many cases, and consequently more power would be extracted from the heating steam and a greater saving would be effected.

We should like to emphasise "W. S.'s" closing remarks, and hope that power users will put their heating as well as power problem before engineers, so that both may be considered together and the most economical combination be arrived at.

GEO. A. WARBURTON, Managing Director.
MARSDENS ENGINES, Ltd.

Heckmondwike, Yorks, October 28th.

JAPANESE TRADE.

SIR,—I have read with much interest the letters from "Outland Voyager" in your issue of October 13th, and from "Columbus" in that of the 27th, and think their importance cannot be exaggerated. To-day, when so many markets for British manufactures, such as Smyrna, Russia and Germany have crumbled, or are crumbling away, it is essential that British manufacturers should concentrate on those which remain. Undoubtedly, Japan offers a very good market for British manfactures. True, the Japanese are each year making more and more for themselves, but for many years to come they will be forced to import largely. I do not need to labour further my first point, which is that Japan has been, and still is, a very promising market for British goods.

The second point is that, unfortunately, during the war the Japanese market was almost entirely captured by America, but this need only be a temporary phase, if England chooses. There are difficulties in the way of recapturing this market. As "Columbus" points out, American specifications, terms and phraseology are becoming current in Japan, and American tests are accepted to the exclusion of British. America also has the advantage of close proximity to Japan, and the fact that the Siberian Railway is no longer operating doubles the time required for a letter to reach England.

At home, the British manufacturer has had many difficulties to contend with during the period of reconstruction after the war—a period when strikes in one trade or another were almost a daily occurrence. But I am convinced after a three months' visit to Japan in the spring of this year that the British manufacturer could improve his service to his agent or correspondent in the East. There are many points where the manufacturer has let down his agent in the East, and it was not due to any of the difficulties caused by the after effects of the war.

Take the case of tin-plates, where, before the war, the British manufacturer led the world. To-day, in Japan they maintain that the American tin-plate is better, or, any way, arrives in a better condition. On close investigation, I believe it has been found that the practice in this country is to sling the tin-plates in the hold 5 or 6 tons at a time, letting them fall carelessly in their position, with no trouble taken to stack them in their proper place. On the other hand, American tin-plates are hand-stacked ½ ton at a time, each ½ ton slightly overlapping the other. The whole of the sheets are so packed as to arrive in Japan in a perfect condition, with the result that apart altogether from quality the American sheets arrive in an infinitely better condition than the Welsh sheets can possibly do. Curiously enough, both American and Welsh sheets are shipped on British steamship lines, and it is extraordinary that British shippers do not give the same care to the loading of British sheets as they do to American. It is just through this lack of care and detail that the British manufacturer is losing trade in Japan. I could give numerous instances of similar carelessness, such as travellers arriving in Japan without samples or sufficient information, and delay in sending shipping weights and heavy lifts to the agent in Japan. Even yet, price for price, British goods are preferred to American, and the reputation of British manufactures before the war is still a fact to be conjured with in Japan. But, if, in addition to ordinary difficulties with which British manufacturers are faced in Japan, they add that of carelessness and bad service to the merchant who is trying to push their wares in a foreign country, I am afraid the outlook for employment at home is bad indeed.

Another criticism I have to make of the British manufacturer is that in cases where he has his own representative out there, he keeps him short of staff. I well remember asking a well-known representative of an engineering firm why he had not visited a certain part of Japan where large engineering enterprises of his particular line were being undertaken. He replied he could not be everywhere, and that if his firm would allow him another assistant, he could easily obtain much more business. I might add that this representative was not a man to make ungrounded complaints, and that he is well known in Japan as one of the most competent engineers out there, and before I left he had taken several large orders from under the nose of the Americans. I am sure this attitude on the part of firms at home is due to ignorance of the possibilities of Japanese markets.

As a result of my visit to Japan, I venture to put forward a suggestion that it would be worth the while of the British manufacturer to cultivate Japanese markets. There are big schemes on hand, such as the hydro-electric power stations, the electrification of railways and the laying down of an underground system both in Osaka and Tokyo.

The Japanese lately took the trouble to send a Trade Mission to England. In view of the efforts being put out by America and Germany to capture the markets in Japan, surely it would be worth while sending out a mission to Japan. No one welcomes advice more than the Japanese, and many complained to me that they never saw an English expert, and that it was only the Americans who took the trouble to visit them. It must be borne in mind that for such a mission to be a success, really good men should go out. Japanese are no longer content to see No. 2. If an expert goes, he should be the leading expert in his particular line, otherwise his efforts will be wasted.

November 1st. TRAVELLER.

HOLLOW COIL SPRINGS.

SIR,—We have been trying to find a firm which makes hollow coil springs from tube of about 1¼in. diameter, but have been unsuccessful. The writer understands that the Air Ministry has also been trying to find someone who can do this class of work. Possibly some of your readers could supply this requirement.

A. V. ROE.

Hamble, Southampton, October 31st.

The Fleetwood Automatic Telephone Exchange.

BEFORE the war considerable attention was being paid in this country to the development of automatic telephones, and there is no doubt that had conditions remained normal progress would have been rapid. One of the systems which was brought to light some little time before the outbreak of hostilities put a stop to practically all industrial activities, was that invented by Mr. G. A. Betulander, of the Swedish Telegraph Department. The right to use the patents for this system in all parts of the world, with the exception of Sweden, was acquired by Marconi's Wireless Telegraph Company in 1913, and in August of the same year the Betulander Telephone Company was formed. Several installations built in accordance with the original Betulander patents, which involved the use of novel electro-magnetic switches, were put into operation, but after various improvements had been made with a view to reducing the number of these switches, a new trunking principle was finally evolved. This new system ultimately led to the complete abolition of the electro-mechanical switches, which were replaced by simple telephone relays as commonly employed in manually operated exchanges. Although the idea of using relays exclusively is not by any means new, the number of relays required has hitherto been excessive, except in the case of very small exchanges. The first switchboard equipped entirely with relays, and for the operation of one hundred lines was brought to this country in the early part of 1914, and the results of tests on this switchboard were so promising that steps were immediately taken to demonstrate that the system could be used with complete satisfaction in exchanges dealing with as many as 10,000 lines.

An installation with this capacity, completed about two months before the outbreak of war, gave results which were so gratifying that it was decided to use the relay system entirely, and the English company was re-named the Relay Automatic Telephone Company, Limited. It was soon realised by the engineers engaged upon the development of the system that the extensive use of relays would remove many of the difficulties which had been experienced with switching systems. The elimination of the switches resulted in a very marked reduction in the operating power, as well as the troubles associated with the contacts carrying the relatively heavy current. The manufacturing difficulties connected with the switch systems were also minimised. During the war endeavours were made to continue the development of the relay system, but although four or five installations were completed, it soon became necessary for the company to turn its attention to the manufacture of war material. Development work in this country could not be continued until after the Armistice. The Swedish company, however, was able to continue with its work and to accumulate new and valuable experience. But at the conclusion of the war the English company immediately made arrangements to continue the development of the system, which has now been adopted in a number of important business establishments. As regards public exchanges, the Swedish company installed in 1917 a trial 1000-line semi-automatic exchange in Stockholm for the Swedish Government, and records show that during a period of two years an average of only one exchange fault was reported for every 92,000 calls, and only one contact fault for every 195,000 calls. Several exchanges which have been supplied by the English company to the India Office have also demonstrated that the system is equally satisfactory in the Tropics.

An automatic exchange at Fleetwood, which we have recently had an opportunity of inspecting, was installed for the Post Office and put into service in the middle of July of the present year. During the three months the exchange has been in operation the number of faults has been extremely low, and during the first few days there were no faults at all. The exchange was designed to meet the requirements of the Engineer-in-Chief of the British Post Office, and during the course of construction each new requirement for automatic exchanges that was standardised by the Post Office and included in its latest automatic exchange specification was added to the plant, with the result that the Fleetwood equipment is now in every way up to date. The exchange is said to be the first of its kind which is completely automatic, for it works without local operators for junction and trunk calls and inquiries. Subscribers are provided with standard Post Office telephones, which are fitted with dials and are connected to the exchange by two wires and without an earth connection. When making a local call a Fleetwood subscriber removes the receiver from its hook, when the dialling tone is immediately heard, and the dial is turned once for each digit. If the called number is disengaged the desired connection is made and the distant bell is set ringing within about five seconds. At the end of the conversation the call is automatically metered against the calling subscriber when he places the receiver on the hook, but if the called subscriber does not answer or certain special numbers are called, the meter is not brought into action.

If a subscriber's meter does not operate correctly a warning signal is given in the exchange, so that the meters are all kept under proper observation. Hitherto it has been usual to place a manually operated board near the automatic telephone board in order that connection can be made by means of junction and trunk lines with the public telephone system of the country, but at Fleetwood there is no local manually operated board. Two wire junctions run directly from the automatic board at Fleetwood to the Blackpool central manual board, which is nine miles away, and when a subscriber makes a call for trunks or any exchange other than that at Fleetwood, he dials 0, and in doing so he gets connected automatically to an idle junction running to Blackpool, where his call is dealt with manually. The Fleetwood subscriber gives a clearing signal to the Blackpool operator immediately he hangs up his receiver. Similarly, for inquiries a subscriber is connected to Blackpool automatically when he dials the figure 9, whilst calls in the reverse direction are completed on the manual board at Blackpool by dialling over a two-wire junction to Fleetwood. In this case the Fleetwood subscriber also lights a clearing lamp in front of the Blackpool operator, when he replaces his receiver on the hook.

In the event of a Fleetwood subscriber being engaged when the operator at Blackpool operates the dial, a "busy back tone" is received and the clearing lamp flashes intermittently. In the case of a trunk call, however, the operator can obtain a connection over a special junction with the engaged subscriber and so offer the call. Operators at the Cleveleys exchange, which is in the same area, can also obtain the Fleetwood calls direct by dialling the required numbers. Obviously, the entire elimination of the operator at the automatic exchange results in appreciable economies. The whole of the apparatus, including the main frame, the intermediate distributing frame, power plant, and relay racks are accommodated on one floor. The exchange is designed for an ultimate capacity of 920 lines, with 40 outgoing and incoming junctions to and from Blackpool and other exchanges, and it occupies a total floor space of 875 square feet. Views of the exchange are shown in Figs. 1 to 6. A view of No. 1 rack, with the in junction feeds, "A and B" feeds, trunk connecting groups, ringing groups and fuse, and alarm groups is shown in Fig. 1. Fig. 2 shows the battery charging board; Fig. 3 gives a view of the back of rack No. 2; Fig. 4 shows the main distributing frame, the intermediate distributing frame, the trunk offering key, and the meter rack in the foreground. The common apparatus rack is shown in the background. Fig. 5 shows the battery, and Fig. 6 the motor generator used for charging and also the main and intermediate distributing frames and the meter rack on the right.

For convenience in manufacture and in order to economise space two, three, or five relays are mounted on a common yoke, and any component part, such as a set of springs, can readily be removed without disturbing the remainder of the relay. Having benefited by an extensive experience in the design of central battery manual exchanges, the engineers of the Relay Company set out to modify the design of the ordinary relay and to produce an article which would rarely require adjusting after it has left the factory. The small brass stud or screw, which is usually fitted to prevent the armature sticking to the core as the result of residual magnetism, has been replaced by a strip of metal which has a much larger area than the screw and which does not hammer out on its own accord and so alter the relay tuning. Moreover, in order to make these relays suitable for tropical conditions the use of fibre and ebonite has been excluded, the only insulating materials employed being micanite and materials such as Empire cloth. A contact pressure of 1¼ ounces per contact is ensured by the use of special bronze springs which do not lose their tension as the result of prolonged use. The total number of relays at Fleetwood is 12,568, which serve for 480 lines, the average being 26 per subscriber's line. When the exchange is enlarged and its ultimate capacity becomes 920 lines there will be 22,025 relays, or an average of 24 per line. By the use of a three or four-digit numbering scheme at Fleetwood the full 1000 numbers can be employed without an additional trunking stage, the amount of equipment required being practically independent of the number of digits in the numbering scheme. The subscribers are numbered from 200 to 709 and from 8000 to 8319. The figure 0 is used for trunk calls and 9 for inquiries. Owing to the liability of a subscriber sending a false impulse when removing his receiver from the switch hook, the figure 1 is not used, and if a false impulse should be sent it simply re-sets the recorder without mutilating the call. In searching for an idle junction in a large group of junctions it takes no longer to search for and connect the last junction than it does to search for and connect the first junction.

In call offices without dials the caller removes the receiver and is automatically connected over special junctions to Blackpool, where the telephonist answers and deals with the calls in the same manner as if they emanated from a call office working in conjunction with a manual exchange. In the case of call offices fitted with coin boxes the caller dials local calls direct, and on hearing the wanted party reply deposits coins to complete the talking circuit. For calls to other districts the caller dials 0 and the telephonist completes the connection and asks the caller to deposit the money, &c.

Thermostatic control of the common apparatus prevents line faults, and the practice of leaving receivers off their hooks from impairing the trunking efficiency of the exchange. Dialling "busy back," number unobtainable, and ringing induction tones are provided and interrupted in accordance with the Post Office standard specification, and the ringing machine starts and stops automatically. In the transmission circuit repeating coils and impedances are included for providing quick and efficient transmission over long distances. A simple power plant, composed of two 32-volt batteries and a charging machine, a switchboard, and two battery ringing machines, supplies all the necessary power. The official report of the company's maintenance department covering a period of eleven and a-half months and relating to various private installations which have been erected and put into use between 1916 and 1921 shows that the number of calls registered was over three and a-quarter millions, whilst the number of pairs of contacts in operation was ninety-six thousand, and out of these ninety-six thousand pairs of working contacts only one in each 2049 pairs required clearing during the eleven and a-half months.

EXCEPT the Western Group, little progress has been made as to the absorption of the subsidiary companies. As with the amalgamation of the constituent companies so with the absorption of the subsidiary—the scheme must, under Section 4 of the Railways Act, be submitted by January 1st, 1923, or a scheme therefor will be prepared by the Railway Amalgamation Tribunal.

THE terms for the grouping of the London and South-Western, London, Brighton and South Coast, South-Eastern, London, Chatham and Dover, and the South-Eastern and Chatham Joint Managing Committee into the Southern Group have now been arranged. They must now be submitted to the stockholders for approval, and then need the sanction of the Railway Amalgamation Tribunal.

AUTOMATIC TELEPHONE EXCHANGE AT FLEETWOOD

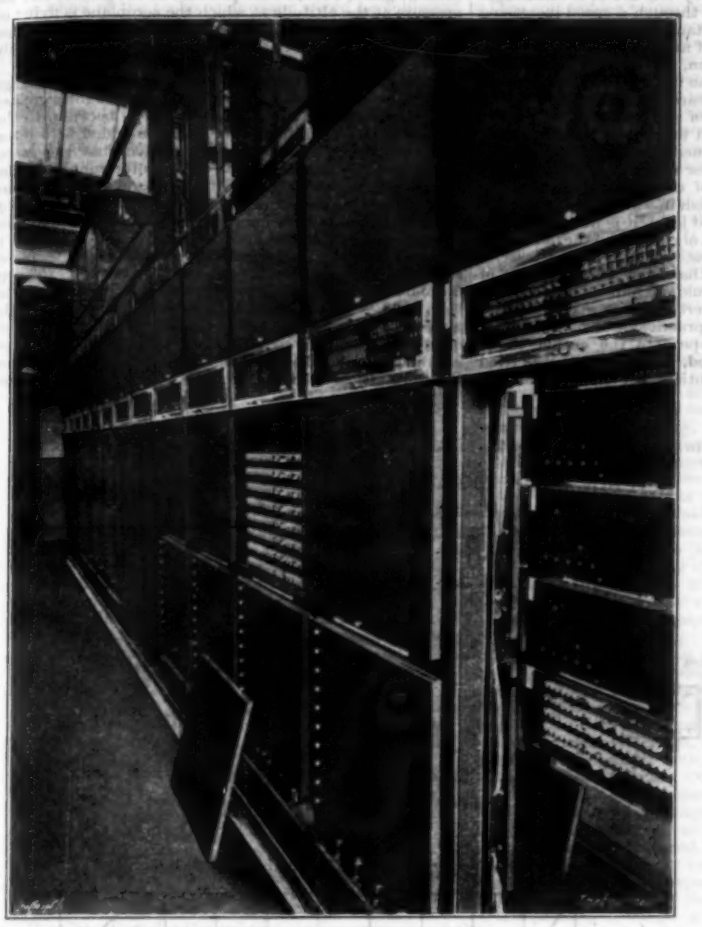


FIG. 1—COMMON APPARATUS RACK

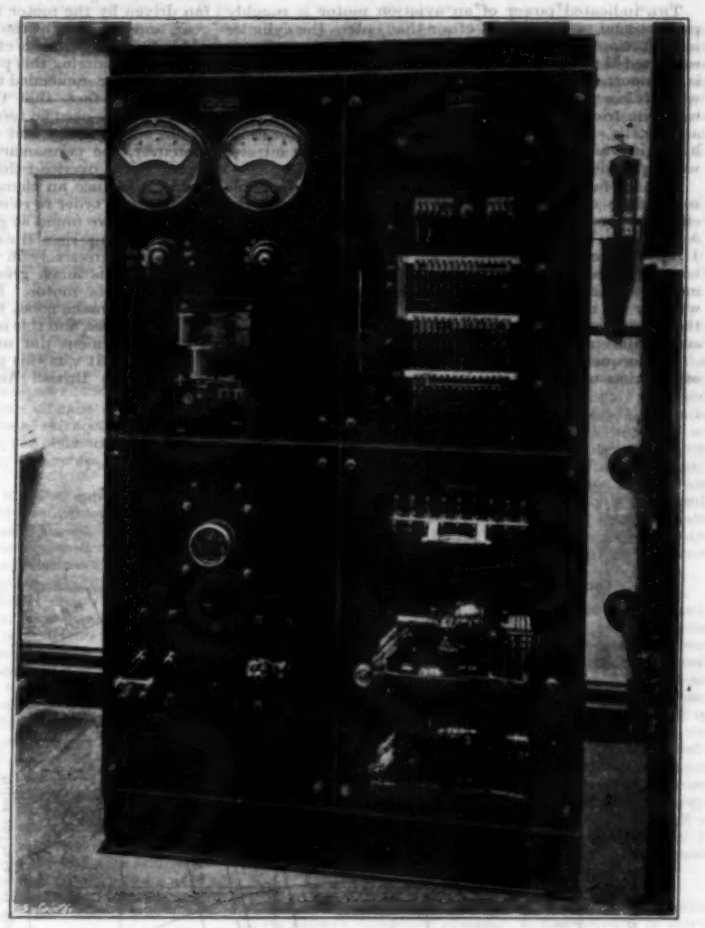


FIG. 2—BATTERY CHARGING SWITCHBOARD

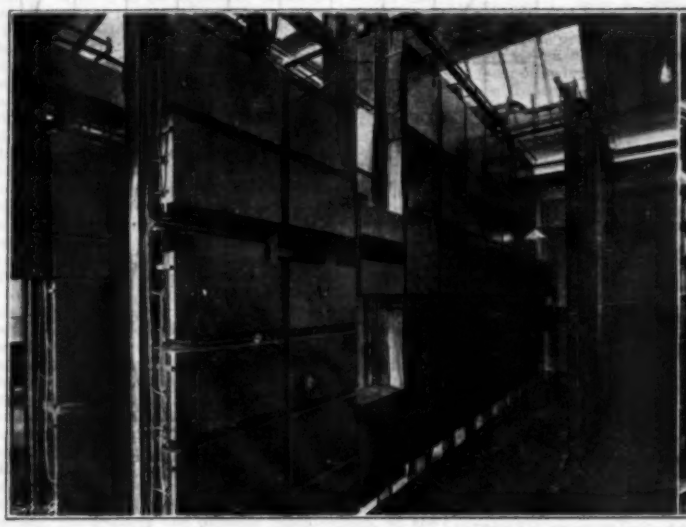


FIG. 3—BACK OF THE RACK

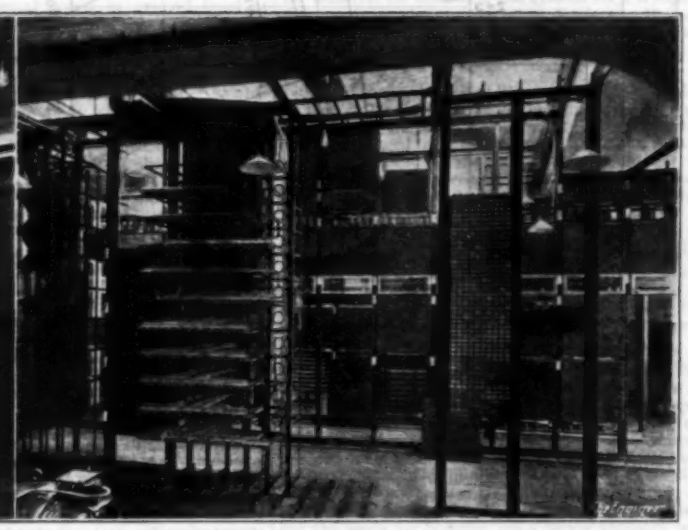


FIG. 4—DISTRIBUTING FRAMES AND METER RACK

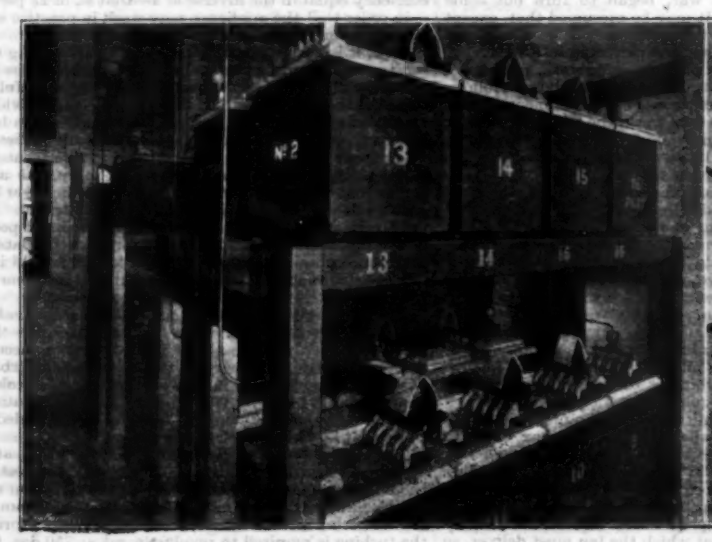


FIG. 5—BATTERY

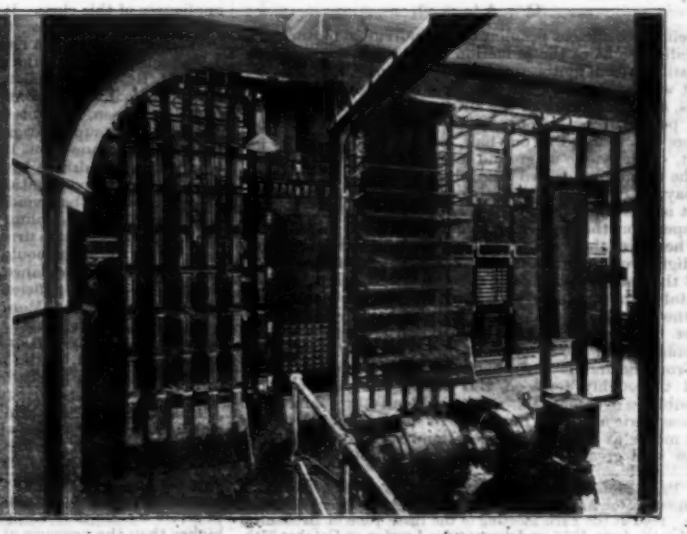


FIG. 6—MOTOR-GENERATOR AND DISTRIBUTING FRAMES

Turbo-Compressors for Aeroplanes.*

THE indicated power of an aviation motor is roughly proportional to the weight of air that enters the cylinder in unit time, always supposing that the carburation is regulated in the same manner; but it is not this power that is of importance; it is the net power at the airscrew shaft, which is less than the indicated power by the total expended in piston friction, the friction in the connecting-rod ends and of the shaft in its bearings, losses due to vibration, losses in valve actuation, and in operating the oil and water pumps and driving the magnetos.

So many factors influence these losses that it is impossible to produce a simple and exact formula connecting the effective power with the air consumption. At best, therefore, it can be said that the present motors give about 1 horse-power per gramme of air introduced per second when working at normal atmospheric pressure; a little more (or a little less) than 1 horse-power, according to whether the motor is above or below the average, whether the lubrication is better effected or no, whether the pressure at the end of the compression is higher or lower, &c.

The torque Q is approximately independent of the speed of rotation within practical working limits, at least for non-rotary motors, and may roughly be given by the very simple formula:

$$Q = A(\varrho - \gamma).$$

A being a coefficient peculiar to the individual motor, ϱ the specific weight of the induction air, γ a constant, characteristic for each motor, differing little from 0.12.

It will be seen at once from this that, as the aeroplane rises, and the density of the air diminishes, the torque and the power decrease more rapidly than ϱ. At 6500 m., where ϱ is reduced to one-half, the torque falls to 44 per cent. of the value at ground level. It would fall to zero if the formula remained true when ϱ fell to 0.12; that is to say, when the altitude Z is approximately 18 kiloms.

It is this rapid fall in the torque which causes the drop in speed on the level and in climbing, and which limits the height of the ceiling. At constant torque the incidence of flight would remain the same as also would the outflow and the power absorbed by the airscrew; speeds for horizontal flight would increase inversely as the square root of the density, and in theory the ceiling would cease to exist. The limit would be attained by the maximum speed permissible for the revolutions of the motor.

From the first days of aviation many ingenious inventors had thoroughly foreseen and shown that it would be possible to overcome this serious difficulty by compressing atmospheric air in the first place in such manner as to feed the motor at a higher pressure, and thus to enable it to draw in a great charge of air; but no one, so far as is known to the author, had yet endeavoured to find a practical solution, until in 1915 the question was put to him by the Lorraine-Dietrich Company. They thought that a solution might be obtained by the use of a centrifugal fan driven by the motor itself through a speed-increasing gear, and they sought the assistance of the author because of his experience in this class of machinery.

After considering this problem, as well as several others, the author recommended that no trials should be made. It appeared, in fact, that the gearing and the fan, which should in this case be formed of several revolving wheels, would be too heavy and would take up too much space; moreover, the permanent connections of the fan to the motor would overload the latter uselessly at starting and would introduce an element of risk. Finally, as will be seen later, in order to re-establish in a suitable manner the initial pressure found at ground level, it is necessary that, as the aeroplane rises, the speed of rotation of the fan should increase progressively in the ratio of 1 to 2.5 at least, a ratio which is much greater than that of the speeds of rotation of the motor. It would therefore be necessary, in order to make good, to insert a change-speed gear, as on automobiles, and this is not practicable on an aeroplane. This arrangement did not appear to the author to be acceptable. It was this method, however, that was tried later by the British Aeronautical Service, the author believes without success, and by the Germans, who, towards the end of the war, began to turn out some appliances of this class. It may be presumed that, except perhaps in special cases, this solution will be abandoned in favour of that which has been perfected in France.

The author had set the problem aside until, in August, 1916, M. Bastiou, the pilot, came to ask his help in following up some investigations which he had commenced. He had clearly seen, from his own work, the advantages to be obtained from supercharging and from running the motor at constant torque; but he also sought for a combination of a compressor driven by the motor.

On further investigation the author found that the objection would be avoided by a different combination consisting of the coupling of the fan, not to the motor itself, but to a turbine driven by the exhaust gases. Provided that the rotor could be caused to revolve at very high speed, the appliance would be small and light, a single wheel being sufficient, both for the compressor fan and for the turbine. Moreover, this would give complete independence of the motor and of the supplementary turbo-compressor, because an ordinary exhaust cut-out capable of being operated by the pilot would enable him to turn the gases through the turbine or to exhaust direct to the atmosphere and even to regulate the action progressively.

In any event, the scheme would not be practical unless sufficient power were available in the exhaust gases to compensate for all the losses in the fan, on the one hand, and in the turbine, on the other hand, without causing excessive back pressure on the motor. Fortunately, by a lucky chance, the compensation is found with a back pressure on the motor approximately equal to or slightly higher than the pressure at which the fan must deliver, so that it is possible in practice at any altitude to restore the motor to almost the same conditions as when running at ground level; the energy obtained by the expansion of the exhaust gases, between the pressure at the ground and the pressure at the altitude at which the aeroplane is flying is, in fact, sufficient to compress the air supply to the higher pressure from the lower. That this is the case can be easily shown in the following manner.

To begin with, it is well to note that if there is no leakage the weight of the gases leaving the motor is slightly greater than the weight of the air that enters it, because, to the air taken into the carburetter must be added 5 to 6 per cent. of petrol; next it must be noted that the gases, which leave by the exhaust from a motor running under normal conditions at ground level, are at a temperature of 800 deg. Cent., or at about 750 deg. Cent. (or 1023 deg. absolute Cent.) after being cooled in the exhaust manifold between the motor and the turbine. If the aeroplane is at an altitude at which the atmospheric air is at a temperature of − 20 deg. Cent., for example, that is, 253 deg. absolute Cent., the volume of gas leaving will be greater than 1023 ÷ 253, or equal to four times the volume of the air entering, measured at the same pressure, and consequently working between the same pressures, the gas that is exhausted should theoretically be able to give four times the work strictly necessary for the compression of the air. Hence it will suffice if the turbo-compressor unit has an efficiency equal to the inverse of 4—that is, of 25 per cent.—in order that the appliance may work in practice within the given conditions.

Now, it is very easy to make, even without going to the most perfect forms, a fan and a turbine in which the losses of energy of every kind are less than the actual useful work done. The turbine and the fan having each individually an efficiency of over 50 per cent., the combination has an efficiency equal to the product, or an overall efficiency of 25 per cent. The actual apparatus has 27 per cent., and, given a slight increase in weight and space, the author thinks that it should be possible to obtain rather over 30 per cent. The solution therefore appears quite hopeful.

The actual designing of the machine presented peculiar difficulties. Even with the large amount of data and experience obtained by previous work in this field it was not possible to attempt a solution without some fear as to the result.

In order to re-establish the air pressure at ground level at an altitude of 5400 m.—that is to say, to double the air pressure, which was the object in view—it was necessary to obtain, at the periphery of the compressing turbine, a tangential speed of 350 m. per second; that is, taking a diameter of 24 cm. as suitable, a speed of rotation of 30,000 revolutions per minute. This greatly exceeded anything that had been previously achieved.

The action of centrifugal force is very great at this speed. The portions of the metal that are furthest from the axis, for example, exert a pull in the direction of the radius equal to 125,000 times their weight; a gramme of matter gives rise to a tensile force of 125 kilos. Moreover, the turbine is required to revolve in gas at 750 deg. Cent.,

FIG. 1.—*Speeds of Rotation of Turbo-Compressor for Restoring Pressure of Admission Air to Normal 760 mm. of Mercury.*

Z = Altitude in km.

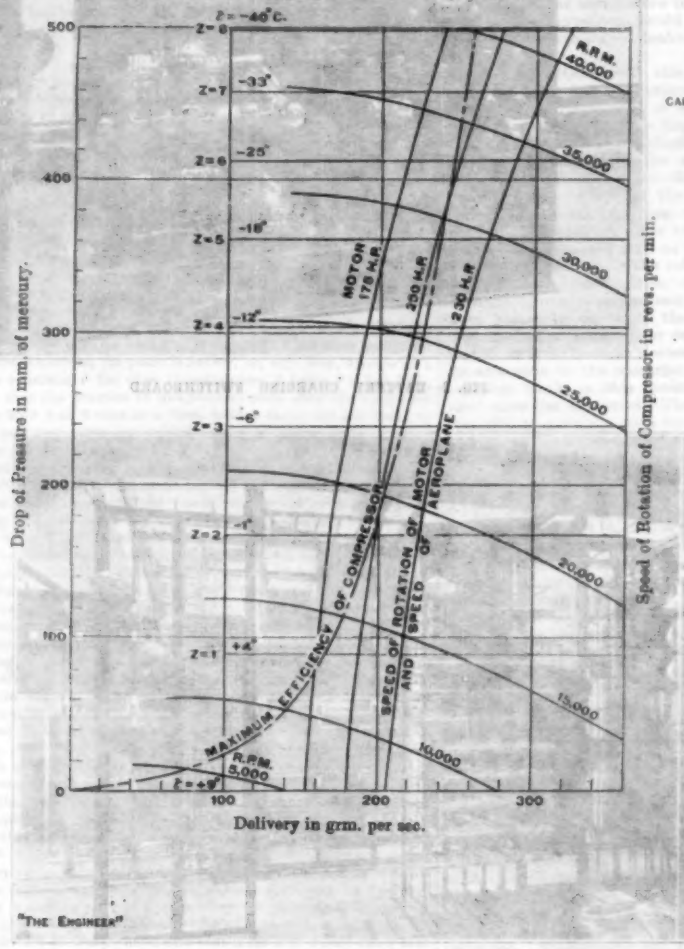


FIG. 2.—*Arrangement of Turbo-Compressor Supercharger.* (Rateau.)

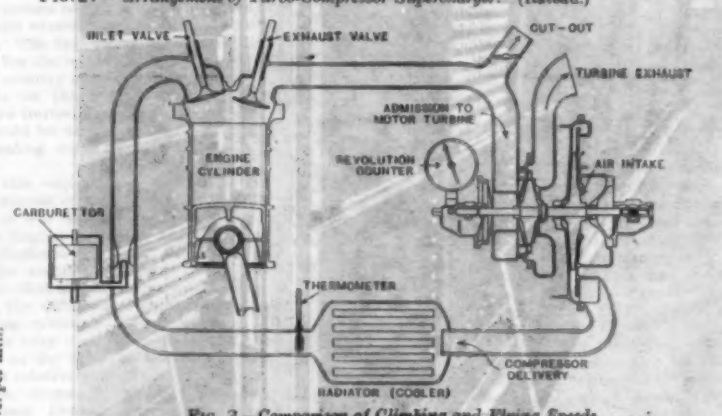
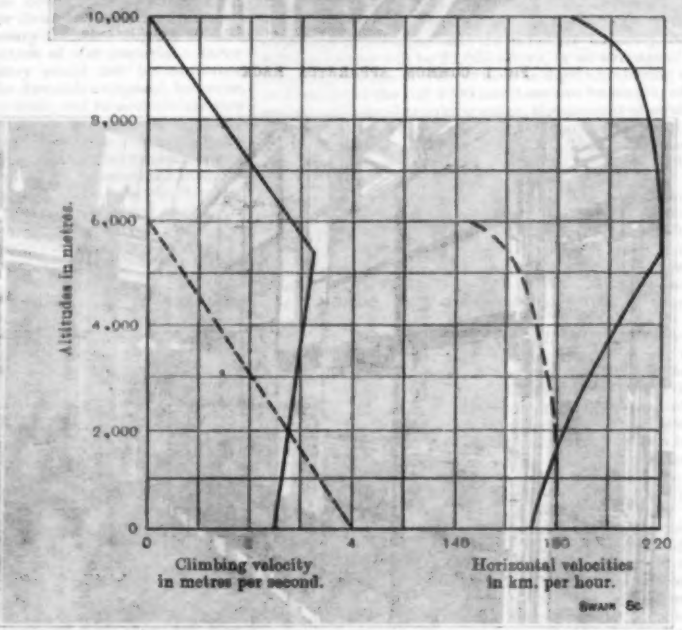


FIG. 3.—*Comparison of Climbing and Flying Speeds.*



"THE ENGINEER"

* From Professor A. Rateau's paper, "The Use of the Turbo-compressor for Attaining the Greatest Possible Speeds in Aviation," read at the Paris meeting of the Institution of Mechanical Engineers, June, 1922, and discussed in London on October 27th.

or more accurately rather less—say, 650 deg.—on account of the expansion in the distributor—that is to say, it is almost at a red heat; and, at this temperature, all metals lose a great proportion of their tensile strength; whereas the wheel of the turbo-compressor would be subjected to very low temperatures, ranging down to — 55 deg. Cent. at high altitudes, when the usual metals of construction become extremely brittle.

The shaft is subjected to other conditions; at the one end it is heated to redness and at the other it is chilled; and there is the further question of dangerous critical speeds should the rotors not be perfectly balanced.

All these difficulties and many others that need not be mentioned were, however, overcome. Thanks to the data previously obtained on these questions, and thanks to the special steels that the metallurgical experts had already produced, it was possible, without going through a process of trial and error, to supply the aviation apparatus in a very reliable form; in fact, much more reliable than the author had anticipated.

The arrangement possesses perfect flexibility; it is merely necessary for the pilot to close the exhaust cut-out gradually in order to accelerate the compressor and the motor to a greater or less degree from the minimum, which corresponds to the cut-out completely opened (the motor then runs as though there were no turbo-compressor), up to the maximum speed when the cut-out is completely closed. In the latter position a sort of automatic regulation of speed takes place.

The diagram shown in Fig. 1 gives the speeds of rotation of a turbo-compressor, of the 175 horse-power type, which are necessary for restoring the ground-level atmospheric pressure at various altitudes.

The output of the turbo-compressor is plotted as abscissæ, in grammes per second; the power of the motor is directly proportional to this output as also is the speed of the aeroplane for flight at constant altitude.

The fall of atmospheric pressure is plotted as ordinates, in millimetres of mercury at the various altitudes. The horizontal lines correspond to altitudes of 1 kilom., 2 kiloms., up to 8 kiloms. for normal barometric height, and the temperatures are marked alongside. The chain-dotted line corresponds to the maximum output of the turbo-compressor.

From this curve it will be seen that in order to obtain the same pressure as at ground level for a motor of nominal 200 horse-power:—

For Z = 1 kilom.	the speed required is	13,300 revs.	per minute.
Z = 2	"	18,500	"
Z = 3	"	22,200	"
Z = 4	"	25,400	"
Z = 5	"	29,400	"
Z = 6	"	33,100	"

It would not be prudent to exceed the speed of 30,000 revolutions per minute appreciably; the coefficient of safety would then fall to too low a value.

If at low altitudes the exhaust cut-out were closed the turbo-compressor would give too high a pressure, a pressure which the actual aeroplane motor is not capable of withstanding. This is to be regretted, because it would have afforded a means for obtaining an appreciable increase in the initial power.

Designed in the first instance for a motor of 175 horse-power, at the beginning of 1917, the turbo-compressor was tested thoroughly in the works, systematically, by means of an experimental arrangement enabling the running conditions to be varied far outside the range of those that would be met with in practice on the aeroplanes.

Thus, in trials at overload, the turbo-compressor was made to revolve at speeds up to 53,000 revolutions per minute, giving a peripheral speed of 670 m. per second at the tips of the compressor. The turbo-compressor drawing from a reservoir and compressing to the atmospheric pressure produced a vacuum of about 60 cm. of mercury; that is to say, it had a compression ratio greater than 4.5.

After these trials at the works the turbo-compressor was handed over to the Aeronautical Technical Section, which took charge of it. Under the direction of Commanders Caquot and Martinot-Lagarde, to whom the author wishes to express his particular thanks, the trials were first made at ground level (at the high-level station at Galibier, 2500 m.) in August, 1917, and then on board a trial aeroplane, by Lieutenants Sadi-Lecointe and Canivet. The manufacture in quantity had been already commenced in a works that had been specially built for the object by the company engaged in the manufacture of the Rateau turbines, when the war came to an end.

Since the Armistice the investigations and applications have been continued steadily. Various details required perfecting, particularly the exhaust pipes, which, at the commencement, were not of sufficient strength to avoid leakage; the petrol pumps also had not been designed to supply petrol at a pressure exceeding one-half atmosphere. Now, however, the engineers and pilots of the Technical Section—Mr. J. Weiss in particular, who worked for a long while in 1919 on a military Breguet aeroplane—whose assistance has thrown much light on the subject, and more recently the devoted pilots of Le Bourget Aerodrome, who kept in regular use a squadron of Breguet aeroplanes, have succeeded in freeing the installations on board the aeroplane from all those inconveniences that had made themselves apparent in practical working. So far as the main feature is concerned—that is, the turbo-compressor itself—no modification was required.

The rotor of a turbo-compressor designed for supercharging motors of 300 horse-power, has a total weight of 3 kilos. The turbine wheel, 18 cm. in diameter, is made of tungsten steel, the tool steel discovered by F. W. Taylor; notwithstanding its small dimensions this turbine develops nearly 50 horse-power with the exhaust gas of a 300 horse-power motor. The compressor wheel or fan, 24.2 cm. in diameter, machined from the solid, is made of nickel steel, as also is the shaft. The blades, nine in number, are exactly radial and machined to the calculated form of a solid of equal strength so that they may undergo no deformation by centrifugal force.

The shaft, which is 33 cm. long between bearings, appears relatively strong, yet its first critical speed is as low as 8000 revolutions per minute, and its second is at 27,000 revolutions per minute. The machine runs normally at 25,000 to 30,000 revolutions per minute, hence in the zone of this critical speed.

In Fig. 2 the general arrangement with a section of the turbo-compressor is shown. The casing of the compressor is in aluminium and that of the turbine in steel plate. The whole machine weighs only 23 kilos.

A radiator is shown for cooling the compressed air from the compressor before its arrival at the carburetter. It is well known that air becomes heated when compressed; if, for example, air is drawn in at 250 deg. absolute Cent., the heating for a ratio of compression of 2 and an efficiency of 55 per cent. is 90 deg. Cent.; the air, therefore, leaves the compressor at a temperature of 340 deg. absolute Cent.—that is, 67 deg. Cent. It must be cooled if power is not to be lost in the motor. This is very important, not only from this point of view, but also for avoiding any kind of unsteadiness of running which may be caused by this heating.

The whole arrangement, including all accessories, weighs about 80 kilos., under the actual conditions of adapting it to old aeroplanes. It would be possible to reduce this weight very considerably if it were decided to design the motors especially with a view to their use in combination with the turbo-compressor.

The advantage is shown clearly by the figure given above. With an added weight of 80 kilos. the power is doubled at high altitudes for a motor giving 300 horse-power at ground level; on the other hand, an ordinary 600 horse-power motor would weigh an extra 350 kilos. at least. It must be noted also that the 300 horse-power motor, continuing to run under the same conditions as exist at ground level, maintains its efficiency, whereas, on account of passive resistance (engine friction, &c.), the 600 horse-power motor, without the turbo-compressor, shows appreciable falling off in power at high altitudes.

What are the results that may be expected from the new arrangement? Taking into consideration only those appliances that have been actually tested, and give double the induction pressure (and there would be no difficulty, if required, in making those appliances capable of compressing the air to a much greater ratio), the formulæ which the author has established show that, for equal weight of aeroplane, there is an increase of about 4000 m. in the height of ceiling. And actually on a Breguet aeroplane having its ceiling at about 6000 m., Lieutenant J. Weiss, after a turbo-compressor had been fitted, flew, in July, 1919, with his mechanic, to a height of over 9000 m., and he was still far from the new ceiling. This is the record for height with a passenger. The absolute record for height is held by the American, Lieutenant J. A. MacReady, who flew, on September 28th, 1921, from the Cookfield Aerodrome, near Dayton, Ohio, to a height of rather over 10,500 m. on an aeroplane fitted with a 450 horse-power motor and a turbo-compressor modelled on the author's design, so far as concerns the essential features.†

With regard to speed, there is a loss at ground level, because it is necessary to change the airscrew and to substitute for it one of larger diameter in order to be able to maintain the speed of the motor at high altitudes within the permissible range of speed. But above 2000 m. the turbo-compressor rapidly makes up for this. A few figures will serve to explain. The Breguet aeroplanes in question, fitted with 300 horse-power motors, without turbo-compressors, have a normal speed at ground level of 180 kiloms. per hour; near the ceiling this speed falls to 145 kiloms. per hour. With the addition of the turbo-compressor a speed is obtained at the former ceiling height of 6000 m., which from many measurements has been found to be from 215 kiloms. to 220 kiloms. per hour. At this speed many flights have been made with these aeroplanes from Paris to Lyons, to Tours, to Nancy, to Metz, &c.

The diagram shown in Fig. 3 gives a clear idea of the comparison of the speeds at constant altitude and in climbing for the particular case under consideration. The broken lines relate to the normal aeroplane and the full lines to the aeroplane fitted with the turbo-compressor.

The reduction of speed near the ground is due to the airscrew having a greater pitch than that for the normal aeroplane and because the motor consequently runs at an appreciably slower speed. This disadvantage could be avoided by the use of an airscrew of variable pitch so as to enable the motor to be run under all conditions at its proper speed. But it will be seen from the curves that the advantage to be obtained from this is not important.

On the other hand, it would not be possible to avoid the use of an airscrew of this type if the turbo-compressor were arranged for running so as to give the ground pressure at an altitude of 10 kiloms. to 12 kiloms. instead of at 5 kiloms. or 6 kiloms. With an airscrew of constant pitch too much speed would be lost near the ground level and taking off would be difficult, if not impossible.

There is no difficulty in designing turbo-compressors for these great altitudes, for which it would be necessary to raise the pressure four or even five-fold, either by means of a multicellular compressor with two or three wheels, or, better still, by arranging in series two turbines similar to those described.

† This notwithstanding, the engineers of the General Electric Company have endeavoured to spread the belief that they had invented the apparatus themselves. Proof exists that their designs were only commenced after the French trials at Galibier in August, 1917, and that they were in possession of the information contained in the first working drawings and of the results of all the trials made at the Villacoublay Aerodrome.

Australasian Engineering Notes.

The New South Wales Government has unanimously adopted the Murray River agreement with Victoria, whereby the latter State will undertake an extensive policy of railway construction in the south-west of New South Wales. Approximately, 250 miles of line are provided for in the agreement, and time limits have been imposed for their completion, three years being allowed for the longest section, namely, 120 miles, from a point between Moama and Mathoura north-west to Moulamein, and thence to Balranald. Victoria's incursion into the neighbouring State will necessitate the construction of several new bridges across the Murray River. The agreement has yet to be ratified by the respective legislatures.

* * * * * *

It is officially stated that £5,792,502 has been spent on the work of electrifying the Melbourne suburban train system to August 21st last. The scheme will be completed early in 1923, when the total cost is estimated at over £6,000,000, as against £3,106,520, which it was estimated the work would entail when commenced ten years ago.

* * * * * *

Following the precedent set by Victoria and New South Wales, it is possible that South Australia will shortly introduce the rail motor coach on the State railway system. Speaking in the House of Assembly a short time ago, the Commissioner of Public Works and Railways, Mr. Hague, states that the Government, as the result of inquiries conducted by the Railways Commissioners, intended to purchase some of these cars for use on certain lines in the State.

* * * * * *

A deputation of twenty-five influential persons in the Victorian mining industry, including representatives of the Chamber of Mines, has appealed to the State Ministry for a grant of £25,000 per annum to revive the gold industry in Victoria. The Minister of Mines, who personally received the request, promised to submit the deputation's memoranda to the Cabinet, remarking that it would be a calamity to allow this industry to go out of existence. Speaking in the Legislative Assembly, the Western Australian Minister of Mines, Mr. Seaddan, said that laboratory experiments with the metallic contact process for low-grade copper ores had disclosed that 5 per cent. ore could be handled, whereas hitherto anything under 8 per cent. was unprofitable. Two-load furnaces are operating at the Chillagoe (Q.) State smelters, where operations were resumed at the end of July. Seventy-five additional men have been engaged for mining and smelting work. At present, it is officially stated, only silver lead is being smelted, though it is intended later to start on copper of the higher grade. It is anticipated that about 600 tons of silver lead bullion will be turned out monthly in future.

* * * * * *

The growth of motor freight services from Melbourne to various provincial districts has become so substantial that action is to be taken by the Victorian Railway authorities to counteract this competition with the railways. In those portions of the State where the roads are suitable, regular services of motor vehicles have been established, and apart from benefiting to the extent of up to 6s. a ton as compared with the railway charges, consignees declare that breakages are rare. The road traffic is said to be increasing, particularly in localities in which, owing to bad roads, difficulty is experienced by farmers in getting their produce to the railways. The Railways Betterment Board is investigating the matter, and it is considered likely that the Government will be asked to introduce legislation authorising the imposition of adequate licensing fees.

* * * * * *

The New Zealand Government is effecting an alteration in its railway signalling system. It has decided to introduce the daylight coloured light signals, similar to those installed on the Liverpool Overhead Railway. An order for material for installing the system on a trial section of line has been already placed in England. If the experiment proves satisfactory, the system will be extended to the whole of the Dominion railways.

* * * * * *

The Borough Council at Taumarunui (N.Z.) has decided to undertake the work of laying an intake and pipe line in its hydro-electric scheme by day labour. Tenders for the work ranged from £14,897 to £32,880, and the Council's engineer estimated that the cost should be £10,217. Tenders for other portions of the electricity works will be called for as required. It is anticipated that the works will be completed within twelve months.

* * * * * *

The Power Board in the Manawatu-Oroua district, North Island of New Zealand, is shortly to take a poll for authority to raise £500,000 to provide for the reticulation of the local area electricity supply. About 700 miles of line, transformers, equipment, &c., would be required.

* * * * * *

The report of the English expert, Mr. F. W. Harbord, on the production of pig iron and steel from New Zealand iron sands has been presented in the House of Representatives. The expert expressed the opinion that the conditions in New Zealand are such that a blast-furnace and modern steel plant were not at present feasible, but if power, coke, coal and limestone were obtainable at reasonable prices, small quantities of pig iron and steel might be produced to meet local requirements partially, this forming the basis for building up a larger industry when the demand increased sufficiently to justify operations on a larger scale.

* * * * * *

A report from Wellington (N.Z.) says that the City Council has for some time been faced with the question of what voltage shall be used when the Government electric supply is available. At present it is 100, but other places in the Dominion use 230. The difficulty is that a change will scrap all existing installations and involve an outlay of £750,000. To get over this, the Council's electrical engineer proposed a voltage of 115, so designed as to be ultimately convertible to the 230 standard. Outside exports were called in, and were unanimously in favour of a voltage of 230, which the Council has adopted, leaving the financial question to be adjusted later.

* * * * * *

A scheme of electric street lighting to supplant the existing gas service has been adopted by the City Council at Auckland (N.Z.). Alternate schemes were jointly placed before the Corporation by the city engineer, Mr. W. E. Bush, and the electrical and tramways engineer, Mr. F. E. de Guerrier. The work, it is thought, will be completed by 1927, when the cost will reach £25,000 per annum.

We are pleased to hear that Mr. G. Lambert Gibson, whose courtesy to us in connection with the new works at Fishguard we much appreciated, has been appointed resident docks engineer at Port Talbot, Great Western Railway.

The Care and Maintenance of Diesel Engines.*

By GEORGE E. WINDELER, M.I. Mech. E.

(*Concluded from page 448.*)

Packing of Fuel Valves.

It is essential that care should be exercised when adding to or replacing the packing in the stuffing-box of the fuel valve. The following is recommended as the most convenient method of packing the stuffing-box. Remove the gland casing and clamp it into a vice after seeing that the stuffing-box is quite clean. Take a single ring of packing and press it into the stuffing-box with a gun-metal distance piece provided for the purpose; screw the gland down on to the distance piece and squeeze the packing down hard. Insert the fuel valve and the tool provided for the purpose and work the valve to and fro by hand through the packing, gradually tightening the packing ring until it cannot be tightened any more. Remove the distance piece; insert another ring and a shorter distance piece; deal with it in the same manner as the first ring was dealt with, and continue to do this until the stuffing-box is full. To obtain the best results it is important to observe:—(*a*) That each packing ring be dealt with separately; (*b*) that each packing ring be compressed as tightly as the tools provided for the purpose will permit; (*c*) that the needle valve be worked to and fro until it moves through the packing quite freely.

Occasionally, when the casing is removed to examine the pulverisers, the packing should be tightened up and the needle valve worked through the packing until free. If this practice is adopted, very little trouble will be experienced, and a sticking needle valve will be a remote possibility. It is most important to observe that tightening up the fuel valve packing gland when the engine is at work is a risky and unsatisfactory proceeding. The packing used is generally white metal shred packing, and is available in compressed rings of the correct size to fit the stuffing-box. The same material and method are used to pack the fuel pump glands.

Fuel Pumps.

These details require very little attention beyond cleaning out of the sump chamber every few months, and

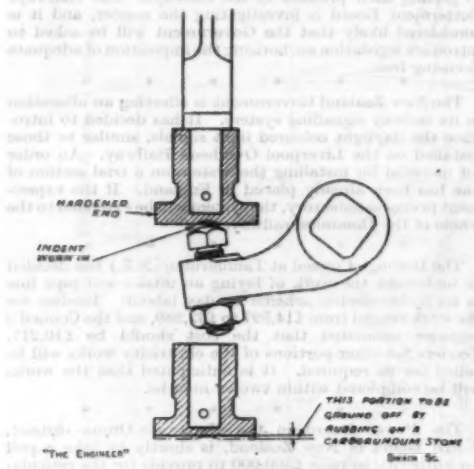


FIG. 4—FUEL PUMP TAPPET

attention to the draining off of water before starting up and occasionally during running. This is particularly necessary where heavy fuel oils are used, as experience has indicated that the heavy oils hold water in suspension.

The valves should be rubbed in once a year, and any ridges removed with a small, smooth file. If the valves require re-seating it is suggested that they should be treated in the same manner as was recommended for the conditioning of the fuel valve. The use of hard abrasives for grinding these valves is not recommended.

In passing, I should like to refer to the adjustment of the fuel pump mechanism which is provided to enable equal powers to be obtained in each cylinder. This mechanism on Mirrlees, Bickerton and Day engines is enclosed in the fuel pump chamber with a view to preventing indiscriminate adjustments being carried out whilst the engine is running. It is, however, easy of access when the engine is shut down, but one little point has at times been overlooked when adjusting the clearance between the control tappet and the fuel pump suction valve. After a lengthy term of service it is possible for an indent to be worn in the hardened collar which is secured to the underside of the suction valve, as shown in Fig. 4. If the collar is removed and rubbed on a carborundum stone until the recess is removed, a correct adjustment can be made with certainty.

Valve Adjustments.

On the engine built by the author's firm the mechanical clearances required between the rollers on the levers and their respective cams are clearly stamped on the levers, and a certain point is marked thus ↑ on the cam profile to indicate the position at which the clearance is to be taken. The adjustment should be made when the centre of the roller is over the mark. It is necessary that adjustments to valve tappets and their clearances should be carried out periodically, usually when the valves are being changed, but it is strongly recommended that these adjustments should not be made while the engine is hot. This warning refers in particular to the fuel valve adjustments. If adjustments are carried out while the engine is hot, it is possible for the clearances allowed to be reduced to zero after the engine cools down. Under such conditions difficulty will be experienced in starting up, and in any case difficulty will be experienced in maintaining the air injection pressure if a start is made.

A case in point occurred where trouble in starting was repeatedly experienced and renewals of certain parts were excessive. On investigating the matter it was found that two out of the four fuel valves (four-cylinder engines) were melted away at the ends, and the pulveriser nut and fuel casing were badly burnt. The conditions of service were that each engine should run continuously at full load for a week and then be shut down for twenty-four hours. (No water was run through the engine after shutting down.) After stopping the engine, and whilst it was hot, the engineer immediately proceeded to adjust his valve clearances, and to change the exhaust valves, &c. At the end of the twenty-four hours the engine was again run up. Not always, but frequently, starting trouble occurred, but was eliminated when the adjustments were made after the engine had cooled down.

Exhaust Valve Covers.

Several cases have occurred where the exhaust valve guide and cover which holds this valve seating in place has been broken. Observations have shown that the fracture has invariably been due to unequal tightening down, i.e., one side has been tightened down unduly, causing a very severe bending stress at the root of the flange. This stress, added to those produced by the expansion of the seating and by the load due to the compression pressure, may result in the fracture of the flange as shown in Fig. 5. This difficulty is easily overcome by tightening down the nuts evenly on each stud and finally nipping them up by hand with a spanner. The joint faces being metal to metal, it is quite impossible to tighten them any more by the use of a hammer. Further, excessive tightening up produces undue stresses on the valve seatings and distorts them.

Exhaust Valves and Casings.

When the exhaust valve casing is removed from its cylinder cover, and before the spare is fitted, care should be taken to remove the carbon which is deposited on the

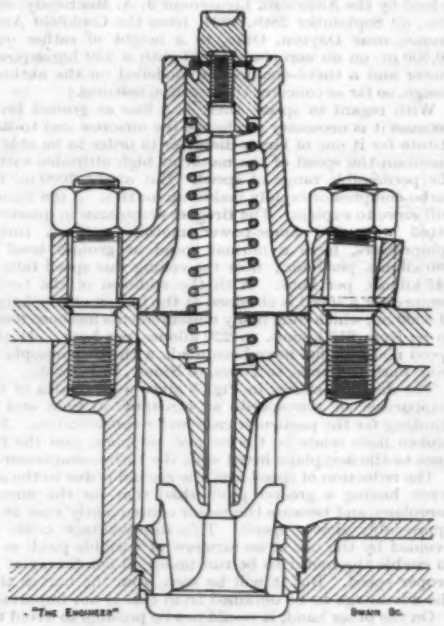


FIG. 5—SECTION THROUGH EXHAUST VALVE CASING

walls of the valve seating recess in the cover and also to see that the seating in the cover is clean. If the carbon is not removed it is liable to be scraped down on to the seating in the cover when placing the spare valve and casing into position, and some of this carbon may be trapped between the seating in the cover and the valve casing. This would cause loss of compression, and in all probability the fuel oil admitted to this cylinder would fail to ignite. At least twice a year it is advisable to grind the valve casings (particularly those of the exhaust) on to their seatings in the cylinder cover. When this is to be carried out, the seating in the cylinder cover should be cleaned and lightly rubbed with rouge or red lead marking. The valve casing should then be rubbed on the seating and the markings on the seating of the cylinder cover noted. If not marking equally all the way round, the valve casings, including the working spare, should be ground into the cylinder cover until an equal seating is obtained. If the seating in the cylinder cover is out of round and the valve and casing be fitted to same, the valve casing will assume the same degree of ovality, and will in turn distort the seating for the valve, and as the valve itself will remain round there will be a space between it and the casing for part of the way round on the valve facing. This will not only tend to cause faulty starting by loss of compression but will permit the high-temperature gases during the combustion period to escape through the interstice thus formed between the valve and its seat, and will burn away the valve facing very quickly. In short, if not detected, it will cause quite a lot of trouble.

The author strongly recommends the more general use of pyrometers or thermometers for the recording of temperatures of the exhaust gases, as this will be found to be a ready and reliable means of detecting leakages and overloading.

Pistons and Connecting-rods.

It is surprising how long a piston can remain in a Diesel engine without requiring withdrawal for cleaning, but nevertheless it is recommended that main pistons and air compressor pistons should be removed for cleaning once per annum.

When the piston is removed for cleaning, the opportunity should be taken to examine and, if necessary, adjust the top end or piston-pin bearing of the connecting-rod. The connecting-rod bolts should also be removed and carefully examined over their whole length. The Diesel Engine Users' Association has done much good work in drawing attention to the necessity of a careful and regular inspection of this important detail.

When replacing the piston pin into the piston, care should be taken when knocking it home to avoid driving the pin violently up to the stepped shoulder. The usual method is finally to tap it lightly up to the shoulder and then drive the pin back about $^1/_{32}$in., otherwise the piston is liable to be forced out of shape and cause a seizure after it is refitted in the cylinder. When fitting new piston rings, see that the gap is sufficient to prevent butting of the ring joints when the ring is placed in the smallest part of the bore of the liner. Usually this is at the lower end of the liner as the greatest amount of wear takes place at the upper portion. This is clearly shown by the graphs set out by Mr. Johnston, of King's College Hospital—shown in Fig. 2 *ante*. If the piston is fitted with a loose or separate head, examine all studs, nuts and security devices and replace where necessary.

Crank Pin Bearing of the Connecting-rod.

Where this bearing is lubricated by a centrifugal oiler or banjo, it is recommended that the internal surfaces of the oiler be wiped clean once a week.

It might not be out of place here to suggest that at least once a year these oilers be removed and the oil hole in the crank pin cleaned out.

If a bearing has at any time become overheated it is important in any case to clean out the horizontal hole in the crank pin, as it has been found that pellets of white metal get into this hole and move about until they get trapped in the radial hole or holes and cause a complete or partial stoppage in the lubricating oil supply. Further, it has been found that "flick" from the cotton cleaning rags accumulates in the horizontal hole and forms a hard plug which ultimately blocks up completely or partially at least one of the radial holes. It is found that a length of stout wire twisted into a corkscrew sharpened at the end and slightly hooked is the best tool for removing this fabric plug.

Intercooler Coils.

This detail has formed the subject of much discussion. Without doubt the deterioration or wastage of these coils is largely due to acidity produced by the presence of lubricating oil in high-pressure air. The author is of the opinion that the great improvement in the lubricating of compressors, the use of carefully selected lubricating oils, and the recommendation to renew the coils when the wastage by weight has reached 25 per cent. of the original weight of the coil, have all helped to prevent a recurrence of accidents due to the failure of this detail. Every coil should be weighed when first fitted and the weight stamped on one of the fittings attached to the coil. The weight should be recorded, and each time the coil is weighed the new amount should be entered in the records in red ink under the original weight, and the date appended.

The domes or casings covering these coils are usually protected by a rubber disc, which is intended to rupture at low pressure. It should be noted that pure rubber only should be used and not rubber fabric, as the latter will not rupture so readily and so completely as the pure material.

Air Receivers.

Quite recently the Diesel Engine Users' Association issued a small circular making certain recommendations regarding the attention and care of air receivers and indicating what action should be taken in case of fire.

For many years my firm has arranged the large sets of air receivers above the floor level. All receivers in the future will have openings arranged at each end so that the examination and cleaning of the interior will be facilitated. Also, the receivers will be arranged in a nearly horizontal position above the floor level, and accessible drain valves will be fitted to eject the water from the lowest point. Fusible plugs have also been fitted.

Starting.

The starting up of a Diesel engine of even large powers is a safe and simple operation, as it is invariably carried out by means of compressed air stored in receivers. It is, however, advisable to observe the following points, immediately before starting up. See that the fuel pump "start" and "stop" lever is in the stop position while barring round. Always bar the engine round several revolutions so as to allow lubricating oil to flow between the journals and their bearings. During the barring operation, drip feeds (where these are used) should be turned on, and if forced lubrication is used the pressure should be worked up by means of the hand pump which is always provided on Mirrlees, Bickerton and Day engines. This is important, as it tends to relieve the wear and tear on the bearings.

Do not start up with a high injection pressure, as the engine is only moving slowly at starting up, and the higher pressure will drive the fuel oil into the combustion chamber too rapidly, producing excess pressures in the cylinders and over-stressing the working parts.

It is quite unnecessary to use the higher pressure; the engine will start quite easily with an air injection pressure of 600 lb., and I venture to suggest that if the lower pressure is used when starting, the starting air pressure can also be materially reduced, resulting in a further reduction of stress on the working parts. Do not prime the fuel pump unnecessarily, but see that it is free from air locks.

After starting up, do not replenish the air in the starting air receivers by throttling down the air injection pressure at the air injection receiver valve. Put the engine on load and then charge up the starting receivers, raising the pressure as the load increase demands a rise in the air injection pressure.

The throttling of the air injection pressure at the receiver valve is a pernicious and dangerous practice, and one

* Abstract of a paper read before the Diesel Engine Users' Association, October 27th, 1922.

which my firm does not recommend under any circumstances.

TOOLS.

It is recommended that special care should be taken of the tools which are originally supplied by the engine makers, and means should be provided whereby these tools can be stored in such a way that they are available at a moment's notice. Where a number of engines are installed in one station, it is usual for the makers to provide a set of tools and spanners with each engine. In such a case the author would recommend that one set of tools and spanners (spanners up to 1in. in duplicate) should be kept in the engine-room, and that the other sets should be placed in the stores in neat bins, readily available for use if required.

It is deplorable to see the unhappy way in which these matters are handled in many stations. The time lost by men being expected to carry out jobs with tackle which is quite inadequate for the purpose in hand cannot be estimated, all because the proper tools are not available through carelessness and inefficiency in storing and maintaining them in good order.

OVERHAUL LOG.

It is advisable for the sake of reference and for comparison between different sizes and types of engines to record in a concise form the work done on an overhaul, or partial overhaul, of an engine. The record below (which is an extract from Mr. Johnston's Log File) gives some idea how simple the records need be. This entry, coupled with the crank shaft alignment report and the liner wear "graphs," gives all the information it is necessary to retain.

Partial Overhaul of No. 1 Diesel Engine.—July, 1921.

All liners withdrawn from "A" frames.
Liners Nos. 1, 2, and 3 very tight on bands and excessive strain was put on gear in drawing out. No. 4 liner was a reasonable fit in "A" frame.
Average scale on liners $^1/_{16}$in.
All thoroughly cleaned, calibrated, bands eased and rubber joints fitted.
Water jacket thoroughly cleaned.
Quills cleaned and new joints fitted.
Pistons all in good condition and rings all free.
Gudgeon pins and bearings O.K.
Pistons thoroughly cleaned.
Liners replaced in "A" frames, pistons replaced and lines boxed up.
Compressor big end bearing re-bedded and adjusted.
Intercooler taken apart and thoroughly cleaned.
Weight of high-pressure coil 11/8/21—96½ oz.

TREATMENT AND STORAGE OF LUBRICATING OIL.

Important information has been placed before this Association on the question of lubricating oils and means of filtering, cleansing and storing same after use. Lubricating oils are an important factor in the care and maintenance of all internal combustion engines, and continual investigation has resulted in simplifying what has hitherto been regarded as a dirty, difficult, and costly business.

Adequate provision should be made for:—(*a*) The storage and cleansing of used lubricating oil; (*b*) the disposal of unusable residues from the lubricating oil; (*c*) the extraction of absorbed oil from the cleaning rags, waste, &c.; (*d*) the disposal of the unusable rags, waste, &c. Otherwise, accumulations of undesirable waste matter will take place, resulting in a very untidy, disagreeable state of affairs. Three methods for the recovery of used oils are now generally in use:—(*a*) By the use of settling tanks; (*b*) by chemical treatment; (*c*) by the use of a mechanical separator; all of which, when properly carried out, have given excellent results.

A rough and ready but simple and inexpensive method is the one used by Mr. Mounsdon, of the Sevenoaks and District Electricity Company, who has placed in his power-house a domestic wringing machine, and as each cleanser finishes his wiping round, he passes his rag, cloth or waste through the wringer, and by this means a considerable amount of oil is recovered. This is afterwards settled and filtered with the other used oil.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Trade Position and Prices.

IN iron and steel circles in Birmingham this week some attention has been given to the utterances of the President of the Staffordshire Iron and Steel Institute, Mr. J. Payton, who, in addressing the Institute at Dudley on Saturday, recalled the fact that last year he had expressed the opinion that the demand for products could not be created while comparatively high prices reigned. The iron and steel trades had certainly led the way in an endeavour to bring about an equilibrium by an all-round reduction of costs, with, however, not very encouraging results so far. In the past two years we had passed through stages of ridiculously high prices to what now appeared to be as ridiculously low prices, and what was exercising and perplexing iron and steel masters was what was going to be a stable value in comparison with pre-war—namely, such stability in price and conditions as would allow trade and commerce to flow more freely. It was lack of stability that had held buyers off, and was holding them off still, excepting for immediate and essential requirements for fear that in placing anything anywhere approaching a large scale they might be sinking capital at what might ultimately transpire to have been too high a price. In this connection also industrialists here have noted the views expressed last week-end by Mr. John Craig, President of the National Federation of Iron and Steel Manufacturers, that since steel and iron are at prices which do not cover cost, and in some cases do not even pay a share of standing charges, consumers must be prepared, when definite signs of trade improvement appear, for an advance in the present prices.

Electrical Engineers.

Professor W. Cramp, who is this year's chairman of the South Midland Centre of the Institution of Electrical Engineers, in his presidential address at Birmingham on October 25th, criticised the action of the Council in publishing a list showing what interest each member of the Council represented. To him, it was utterly and fundamentally wrong. It led to a pull-devil-pull-baker controversy on every important matter, the question invariably being not what was right and best for the profession as a whole, but which interest could secure the most influence. He advised them to call upon all members in the Council chamber to forget everything but that they were members of the Chartered Institute called together for the advancement of engineering science. He advocated the encouragement and extension of the territorial centres and a much more generous treatment of these financially, and co-operation and, if possible, fusion with other engineering institutions ultimately to form one great English-speaking Institute of Engineers.

More Confidence in the Finished Iron Trade.

There is undoubtedly more confidence in the manufactured iron trade of this district, and ironmasters have this week been disposed to take a somewhat more hopeful view of future prospects than for some weeks. There are more inquiries about, and good-grade bar iron for different departments of engineering has been, and is, in slightly better request. Makers of marked bars have derived some advantage from the improvement in shipbuilding. An indication of the more confident feeling is the purchase of semi-finished steel by local ironworks, while transactions in scrap have been more numerous than for some time. This enterprise is occasionally shown by firms for the time being unemployed, the purchases being made in anticipation of expanding business early in the New Year. The placing of a good deal of rolling stock business with firms in and around Birmingham is also a hopeful development for the ironworks, several of which habitually supply material for wagon building. Marked bar prices remain firm at £13 10s. Good merchant bars command £10 10s. to £10 17s. 6d., and iron strip £10 10s. to £10 15s. The Belgians continue to dominate the market in nut and bolt bars, which have been offered this week down to £8 delivered in the Black Country. Staffordshire mills cannot get near this price without losing heavily. Their general quotation is £9 15s., but this would be shaded if business depended upon it. Common South Staffordshire qualities are said to be obtainable at £9 10s. to £9 12s. 6d. At these prices the business is not worth having, and many mill owners are leaving it severely alone, so that large quantities of the foreign material have been bought. Fencing iron is this week quoted at £9 17s. 6d.

Galvanised Sheets Again Dearer.

Galvanised sheets have again undergone some appreciation, some houses asking as much as £17 this week for 24 gauge corrugateds. This is an advance of from 5s. to 10s. on last week's price. Business is more generally done at about £16 10s., however. It is not easy to account for the action of those makers who have rushed the price up to £17 either on the ground of demand or any great increase in production costs compared with recent weeks; still, the tendency of spelter is upward, and makers are asking more for sheet bars. It is stated that South Wales makers have come to an arrangement to stabilise sheet bar prices at £6 17s. 6d., and this is cited in explanation of the higher values by sheet makers.

The Pig Iron Market.

Orders for pig iron continue scarce and quite small, but occasionally buyers are found willing to increase their orders from 10 tons to 50-ton lots. A little more activity at the forges in this district is indicated by the sales of pig iron this week. The reports from other districts indicate that the blast-furnaces are busy, chiefly on American business, with additional plant coming into operation. No progress has, however, been made here, the two furnaces lately blown out having in prospect a period of idleness extending well into the next year in view of the high cost of furnace coke. In the South Staffordshire, Worcestershire, and Shropshire area only thirteen blast-furnaces are working out of a total of fifty-eight, and taking Derbyshire, Leicestershire, Nottinghamshire, and Northamptonshire, of seventy-three furnaces not more than twenty-six or twenty-seven are in commission. Nor are owners likely to take steps to increase production so long as values are on the present unsatisfactory basis. While attempts to exploit basic pig have met with only qualified success, some of the blast-furnaces now engaged on foundry and forge pig have, fortunately, been making a slightly increased turnover. However, Midland smelters have found it quite impossible to follow the price advance in the North of England, so that the advance in coke prices has made it more difficult for them to pay their way. The Midlands are still getting a small share of the orders placed on American account, but the shipments to be made between now and Christmas do not involve any local stringency notwithstanding the limitation of output. Recent values are upheld.

Steel.

There is not much to inspire optimism in the Midland steel trade, except that there are a number of inquiries in connection with projects big and little. The general attitude of the trade is one of expectation, the belief being that the boom which has commenced in America must soon extend to this country. One effect of the war was to increase the steel-making capacity of the country as a whole by 50 per cent., and a corresponding increase in business will be necessary to bring this additional and highly modernised plant into activity. The market remains quiet. Small bars at £8 15s. are 10s. above the Belgian price. There is no perceptible improvement in sections. Values remain irregular. Billets are quoted by mills at home at £6 17s. 6d. upwards. The serious fall in the value of the franc is being taken advantage of by the Belgians to offer steel at low prices. Joists are quoted at 2s. 6d. cheaper than a short time ago, and although foreign billets have little attraction for the Midlands when the cost of transport from the coast is taken into account, rather large quantities are said to have been brought for delivery at Newport. The price of £3 per ton delivered for native steel scrap is considered a fairly favourable figure.

Engineering Trade Wages.

A revised schedule of wages, applicable to boys and youths in the engineering trade in the Birmingham, Wolverhampton, and Stafford districts, has been agreed upon at a conference, and is recommended for adoption. The reductions will come into operation on and from the beginning of the first full-pay period following November 27th. The new total inclusive rate (base rate and bonus) for the various ages will become:—Age fourteen, 10s.; age fifteen, 12s.; age sixteen, 15s.; age seventeen, 19s.; age eighteen, 23s.; age nineteen, 27s.; age twenty, 31s.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER, Thursday.

Iron, Steel and Metals.

THERE are some signs of a slow improvement in trade conditions, and this in spite of the political disturbance. In Manchester business men seem to be taking the political situation far more calmly than in some other districts. Satisfaction is expressed by the promise of the new Prime Minister that trade and industry are to be let alone for a time. A breathing space of two or three years without any "harassing legislation" will certainly be welcome, and if a reduction of the enormous burden of taxation can come at the same time there will be a chance of recovery. One does not see any probability of a rapid improvement in trade. A little more business is certainly being done, especially in the foundry industry, and this must mean that engineering is on the way out of the stagnation which has been the conspicuous feature with the trade for so long.

Metals.

The slight movements in the copper market do not yet indicate any permanent improvement, but prices do not now seem at all likely to become further depressed, and there is a rather better demand from consumers. The prices in Manchester for refined ingot copper are rather above the London parity, and there seems to be a little more confidence in the minds of buyers. If this spreads we shall soon find that larger stocks of copper are being held by the consumer, and this development will be a foundation for a future rise in prices. Probably consumers are influenced, if unconsciously, by the firmness and comparatively high prices for the other non-ferrous metals. What is wanted to complete the restoration of confidence in the copper market is a more reasonable relationship between the various prices. Engineers would certainly hold larger stocks of manufactured metals if the prices were on a level with a quotation for refined ingot, and they would have more confidence if the prices of scrap metals were not so curiously depressed. Gun-metal and brass scrap, for instance, is selling at from £15 to £20 per ton below its intrinsic value, and copper sheets and tubes are quoted at about the same distance above their intrinsic value; and these discrepancies create a feeling of uncertainty in the minds of buyers. They argue that if trade were good all round prices would be adjusted, and there would be some sort of reasonableness about them; and that the absence of reasonableness shows that trade is sick and a long way from recovery. The rapid advance in tin is now producing a feeling of great uneasiness. Sober men know well enough that the slight improvement in trade is not nearly enough to justify what has taken place in the market during the last month, and the result is a conviction that the greater part of the advance is a matter of speculation and manipulation. It is difficult to say when the break will come, but as the market advances without any considerable trade support, it becomes more dangerous. Consumers of tin will probably do wisely to buy only for immediate use and leave the market to the professionals. The market for lead has been fairly strong, and there is as yet no indication that supplies of this metal are likely to increase beyond the capability of the market to digest them. The Australian output does not come in very large quantities to this market, as the local demand and that from the East seems to absorb the greater quantity. The question of a larger supply from Mexico is still obscure, although some Mexican lead has arrived. Most people think that the price is quite high enough, but few are of the opinion that any collapse is near. Spelter has again been a very firm market, and over £37 per ton has been reached. America, however, is now being attracted by the prices paid there, and some quantity has been sold for shipment to Great Britain during the last two months of the year.

Pig Iron.

The market in Manchester for foundry pig iron is thought to be a little better than it was. As the expectation amongst consumers of a further drop in prices faded away under the effect of the clearances of Scotch and Cleveland iron for the American market, so the iron-founders began to buy pig iron for forward delivery, and instead of giving out orders for the month's requirements, many of them bought for delivery up to the end of the year, and one or two so far ahead as next February. Makers of Midland foundry iron are therefore now well sold, and are inclined to try for rather more money, especially for small lots and for prompt delivery. One hears of 85s. on truck for No. 3 Derbyshire, but probably it is safer to quote this iron at from 82s. 6d. to 83s. on trucks, or from 90s. to 92s. 6d. delivered here. It is, of course, annoying to the Midland furnace owner that he should be selling his iron, without much or any profit, at 82s. 6d. per ton when the Cleveland maker is getting

92s. 6d., and he cannot be expected to bear this position very patiently. The buying of Cleveland iron here is, of course, negligible, and much the same may be said about Scotch, although some of this is being sold here at about £6 per ton. It seems quite possible, if not probable, that in the course of the next two or three months Cleveland iron will come down a little, and Derbyshire iron will go up to meet it. A permanent difference of 10s. per ton is not possible.

Steel.

The situation here appears to be unchanged although there are people who say it is better and that there is more business doing. At any rate, the prices remain unprofitable, and makers of finished steel are only half employed. Meantime the prices on the Continent are still on the down grade, and one hears of heavy steel rails being offered at £7 f.o.b. a continental port. It is not easy to see how the British export trade can compete against this state of things while makers of British semi-steel are asking £7 for soft billets.

Scrap.

The demand here for scrap of all kinds remains very poor. There is plenty of good foundry scrap about, and dealers have to sell at from 75s. to 80s. per ton delivered. If the makers of foundry pig succeed in putting up the prices there may then be a chance for cast scrap, but the consumption will have to improve a good deal before it is equal to the supply. Heavy steel melting scrap is a little better, but this kind has been depressed more than any other kind. For heavy wrought scrap 65s. is still being paid at the Lancashire ironworks.

The Institution of Mechanical Engineers.

It was a happy idea on the part of the Committee of the North-Western branch of the Institution of Mechanical Engineers to open the session with a dinner, and the large attendance of members at the second function of the kind, which was held on Friday last at the Midland Hotel, demonstrated that the innovation is approved. About 160 covers were laid. Mr. Charles Day, the chairman of the branch, presided, and after the loyal toast had been honoured he gave a short address. He said that in the engineering industry the worst was now over, and prophesied that there would henceforward be a steady but not rapid improvement. He urged the necessity for a reduction in the cost of production without further reduction in wages, and said that this could only be brought about by active effort in organisation and by improved methods, both of which would be helped by co-operation between the workers and the management. He suggested the necessity for making work in the shops more interesting to the workers, and to this end advocated a system by which the occupations could be varied, thus breaking the monotony. The toast "Municipal Institutions" was proposed by Sir Henry Miers, Vice-chancellor of Manchester University, who claimed that the department of technology in the University was second to none in the world. The Lord Mayor, Mr. E. D. Simon, a member of the Institution of Mechanical Engineers, responded to the toast, and in connection with reference to his pet subject —smoke abatement—said it was essentially a matter for engineers, who had only to devise furnaces and open fireplaces which would consume their own smoke to solve the problem. "Local industries" was proposed by Mr. E. C. R. Marks, chairman of the Midland branch of the Institution. Mr. Marks treated the subject in a breezy manner, and indulged in some good-humoured "leg-pulling" at the expense of Manchester. Alderman W. Walker responded in a similar vein. "The Institution of Mechanical Engineers" was proposed in very complimentary terms by Mr. A. S. Barnard, chairman of the North-Western Centre of the Institution of Electrical Engineers, and Mr. Daniel Adamson responded. The toast "Our Guests" was dealt with by Mr. J. Bissett, O.B.E., and replied to by Mr. B. Mouat Jones, D.S.O., M.A., Principal of the College of Technology, Manchester.

BARROW-IN-FURNESS, Thursday.

Hematite.

The position in the hematite iron trade is about the same, despite the statement that the General Election is affecting the market. There is a steady inquiry for both ordinary sorts and special qualities from various sections, including the Continent, and good trade is likely to follow. The Scotch trade is developing, and is likely to improve in the next few months. Wales is also taking increased quantities. Orders from the Midlands are for bigger quantities, but they are for nothing like the amount they were some time ago. As a matter of fact, customers are not booking very far ahead with certain exceptions. During the week there has been a further shipment of pig iron for Baltimore. Ingot moulds and pig iron have gone to Llanelly. One furnace has been put out in Barrow, but another which has been overhauled has immediately taken its place. The prospect of further furnaces going in is not so great in view of the fact that the steel works will cease operations this week-end. The demand for special qualities of low-phosphorus iron is improving on account of the better trade that engineering firms are experiencing. There is a steady business in manganese and spiegel.

Iron Ore.

The iron ore trade is slightly better throughout the district, and more is being dispatched to outside smelters. The mines are at nothing like their full activity yet, and it will be some time before that state can be reported. The trade in Spanish ore is dull, and nothing has come through. The stocks existing at the docks are large.

Steel.

Both the Barrow and Workington rail mills will cease operations this week-end owing to the completing of the orders held. There is not much in the market at present for steel makers, although there are prospects of a better state of things in the New Year. The hoop mills keep fairly busy at Barrow, but the foundries are only partially employed.

SHEFFIELD.

(From our own Correspondent.)

Progress of the Steel Trade.

THE slow improvement of the steel trade is maintained, but there is as yet no approach to anything like normal activity. The strongest department is that concerned with the making of basic steel. There are many furnaces devoted to the production of this material at Rotherham, Park Gate and Penistone, and they are now working well, some of them being almost on full time. Unfortunately, Sheffield itself is not a large producer of basic, and is consequently not enjoying much share of this revival. The position of the acid steel trade continues very disappointing, and Sheffield's capacity for this product is not employed to a greater extent than one-third. The situation at the rolling mills is also unsatisfactory. While one or two of them are pretty well employed, those who work for hire are still finding things very slack. The crucible steel trade, although still badly placed, is improving somewhat, and a few firms have booked business during the past week.

Railways and Warships.

The departments making railway axles, tires and springs are wearing a rather more cheerful look, some new work having come in, but a great deal more is wanted. The call for tenders for the two new warships has given much satisfaction in Sheffield, for, although the amount of work in connection with them, even if it all came to Sheffield, would not fill up all the gaps in local industry. Still, there is a prospect that the city will benefit to a useful extent. Sheffield, as the great armour plate centre of the country, is sure to supply the major part of the protection of the vessels, wherever the contracts for the ships are placed. The construction of the ships will also involve the use of great quantities of tools which are made in the city. The armament firms are in a position to proceed with the work which may be allotted to them, as they have on hand good stocks of material which they obtained in readiness for the programme of building four ships which was adopted last year and then dropped on account of the Washington Conference decisions. Apart from Admiralty work, there is an improved demand for some kinds of engineering tools, as well as saws, files and edge tools, orders for which are coming in more freely than for a considerable time. The colliery developments to which I referred last week are also having a good effect on the tool trades. In addition, there is an improved demand from the collieries for new wagons.

The High Rate Handicap.

The outcry against high rates and taxes, with their crippling effect on trade, continues. The chairmen of several local companies have lately dwelt much on this matter, and have given striking figures as to the handicap imposed by excessive charges. An illuminating instance of the effect of high local rates has now been contributed by Lieutenant-Colonel J. H. Leslie, a local director of Vickers Limited, who is a municipal candidate for the great industrial ward of Attercliffe. Colonel Leslie states that in 1913 Vickers paid in rates £19,000, while for the current year the demand is £65,000. The result of that, he said, together with lessened output, was that, whereas in 1913 the rates averaged 4s. per ton on steel, they now work out at 52s. per ton. The difficulty of obtaining work, in competition with other places, while struggling with a burden like this, is obvious.

Cutlery and Plate.

The old light trades of Sheffield are doing very well in most departments, particularly so in the case of the electro-plate department, which continues to enjoy the revival that set in about a month ago. It is stated that this trade is better employed now than at any time during the last two years, and instances of night and day working are growing. There is a large demand from the home market for small electro-plated goods sent out in cardboard boxes and cases. The trade is not a very profitable one. There is not much inquiry for expensive heavy ware suitable for Christmas presents. The spoon and fork branch maintains the great activity which I have noticed in recent letters, and is finding a market for more goods than at any previous time. Stainless table cutlery continues to be the great standby of the cutlery trade, and the production is on an enormous scale, although there are still some firms which are far from full of work. The competition for home orders is very keen; in fact, some firms of high standing are unable to accept the low prices offered. There is a satisfactory improvement in the demand from Australia and Canada. The seasonal demand for pocket knives, razors and scissors has only been on a moderate scale. The lock-out of the pocket knife operatives continues, only a few firms being unaffected by it, and this fact is an indication that progress in this branch is not fast. The razor trade shows some improvement, but the increasing use of the safety razor tells against the prosperity of this old industry.

Sheffield Technical Societies.

A great deal of useful work for the benefit of those engaged in the trades of Sheffield is done by a series of technical societies, which have sprung up during the last couple of years and have made rapid progress. There are now half-a-dozen of these bodies, devoted to the interests of the cutlery trade, the edge tool and saw trades, the file trade, the silver and electro-plate trade, the rolling, forging and tilting trades, and the foundry trade. The last-named is the latest addition to the list, having been established this autumn. All the societies are co-ordinated and have a joint advisory council, with Professor W. Ripper, the head of the Applied Science Department of the University, as chairman. Mr. W. H. Bolton, of the University, is the organising secretary of all the societies and the meetings are held at the Applied Science Department of the University. The 1922–23 session is now in full swing, and between now and March upwards of thirty meetings will be held for the purpose of discussing various problems connected with the technicalities of the trades, the methods of dealing with foreign competition, and other questions of interest.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THERE is a lull in trade in the North of England, due to the pre-occupation of traders with the General Election. Most of the markets present a quiet appearance, and until the election is over traders are not likely to commit themselves to any extent. At the same time a more hopeful view is taken of the outlook. It is gratifying to record that more plant is gradually being put into operation. There has been a partial resumption at the Eston Steel Works this week, and two more blast-furnace are to be put into operation at the Lackenby Ironworks next week. Both will be engaged on the manufacture of Cleveland iron. The starting of two furnaces at one works is a healthy sign. There are at present thirty-one furnaces operating on the North-East Coast.

Cleveland Iron Trade.

A quieter tone characterises the Cleveland iron trade. Inquiries, however, are still coming forward from America, and it is believed that when the very large quantities already sold have been absorbed further sales will be possible, as prices are still high in the United States and supplies inadequate. Home needs appear to be expanding, but consumers regard present prices as too high, and many are either holding off the market altogether or using iron from other districts. Another adverse factor has been the further disturbance of the continental exchanges, which always retards trade. In this case it has arrested the continental demand for local iron, and has led to continental competition in the home market. No foreign iron has been recently imported into the district, but offers of cheap iron are now on the market and may lead to business. Certainly Cleveland pig iron at 92s. 6d. is too dear. True, the ironmasters have warrant for the advance in the rising price of coke, but it is not easy to pass on the increased cost to the consumer, who simply refuses to pay. For the time being Cleveland pig ironmakers are not badly situated for orders, but they are booking very little fresh business. Current quotations are maintained, No. 1 and siliceous iron being 97s. 6d.; No. 3 G.M.B., 82s. 6d.; No. 4 foundry, 90s.; and No. 4 forge, 85s.

Hematite Pig Iron.

A very firm feeling prevails in the East Coast hematite pig iron trade, and a steady expansion of trade is probable. Recent sales have absorbed stocks of several producers and taken up their output for the next few weeks, with the result that they are not in a position to offer iron for early delivery. Home inquiries are on quite a good scale, and a fairly substantial business with America is said to be passing. Mixed numbers of hematite are firmer at 93s. per ton both for home use and export.

Iron-making Materials.

The position in the foreign ore trade has weakened considerably and it is now possible to purchase best Rubio ore at 22s. 6d. per ton c.i.f. Tees. The coke market, on the other hand, is exceptionally strong, and good medium furnace qualities are quoted from 31s. to 31s. 6d. per ton delivered at the works.

Manufactured Iron and Steel Trade.

A decidedly more hopeful feeling is taken as regards the prospects in the manufactured iron and steel trade, a most welcome feature being the partial opening out once more of the Eston Steel Works, which have for so long been laid idle. A few orders are said to have been secured this week. The rapid rise in the price of spelter has stiffened the price of galvanised sheets, which are now quoted £17 per ton for 21in. gauge, and even at that figure are not freely obtainable. Otherwise prices remain unchanged.

The Coal Trade.

The Northern coal trade position is not greatly changed from recent conditions, though the outlook can hardly be said to be as assured and unclouded as it was. For one thing, the sensational rises and fluctuations of the German market are having a greater effect on the minds of the exporters than might have been supposed, and, as there are cancellations and postponements of deliveries which are now in process of shipment, exporters are having a most anxious time. Moreover, the market depends so much at present on the continuation of the German trade that everything which affects that to any extent instantly reacts adversely on the coal position here. There is just now a decided lull in the matter of forward contracting. Operators are pursuing a policy of waiting and are not at present inclined to concede the colliery demands, which, in their turn, are inclined to consider counter offers, especially so in the case of many of the Durham collieries, whose ideas are not quite so extravagant regarding next year's possibilities. There are said to be some feelers from Canada, but the season is too late to expect much business from there for some time to come. South American buyers are also reported to be making preliminary inquiries for forward supplies, but no business has been recorded. The Italian market is disturbed and not much is likely to be done for Italy until the political situation there has undergone a change for the better. The Scandinavian inquiries continue fairly active, and the Norwegian State Railways are in the market for 15,000 to 20,000 tons of Northumberland or Durham best steams for shipment during November and December. Steam coals are very firm for prompt and

any date before March next year, which applies equally to second screened as well as bests and unscreened. Small steams, however, are very patchy for prompt, but steady for forward. The gas coal market is strong for both prompt and forward, though some odd lots are obtainable of both second gas and coking for spot at a discount when spot teem can be given. The coke market is steady throughout and supported by a brisk demand.

Cleveland Miners' Wages.

The Cleveland mineowners and miners' representatives have agreed upon a reduction in the scale of pay of 3 per cent. on the base rates. The men's wages now stand 82 per cent. above the base rate. A conference is to be held between the parties to try to reach some arrangement which will enable more furnaces to be started in the Cleveland and Tees-side district.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding Returns

THE shipbuilding returns for Scotland for October record the launching of twelve vessels of 70,152 tons aggregate. Of that number six vessels of 53,670 tons were launched on the Clyde. For the Clyde total two vessels were largely responsible, namely, the Franconia, twin-screw geared turbine, 20,000 tons, for the Cunard Line, and the Conte Verde, twin-screw geared turbine, 18,500 tons, for the Lloyd Sabando Societa Anonima per Azioni Genoa. Chief of the others were the Drechtdyk, twin-screw motor, 9000 tons, for the Holland-America Line, Rotterdam; and the Famaka, 6000 tons, for the Khedivial Mail Steamship and Graving Dock Company, Limited, London. Outwith the Clyde area two important ships were launched, the Manoeran, s.s., 9500 tons, built at Alloa for the Hoomvaart Maatschappij Nederland, Amsterdam; and the British Commodore, 6900 tons, built at Dundee for the British Tanker Company, Limited, London

Shipbuilding Outlook.

The future of the shipbuilding trade is yet rather too much of a problem to allow of anything in the nature of prophecy. New contracts have been announced, but these must necessarily be of a speculative nature fostered by the determination of the builders to keep their yards going at all costs. If the contracts accepted work out at nothing below cost on the average expectations will practically be realised. It is said that work is now not being accepted on the time and lime basis, and the risks are all taken by the builders. It is expected that the wages decrease will be accepted by shipyard trade unions despite the adverse vote, but, even though, the costs of production would still be too high to induce owners to place contracts on the scale necessary to place the industry on a solid basis. Prospect of peace in respect to wages is certainly an asset, but until the last withdrawal instalmant has come into operation a stabilised level of rates is impossible.

New Work.

While the orders recently placed for new tonnage cannot have a great effect on trade, it is gratifying at least that these have been placed, and that others have been announced within the past day or two. It is reported that Messrs. Denny Bros., Dumbarton, are to build two new liners of about 5000 tons each, while the Fairfield Company is to build a new vessel for passenger and cargo use.

Pig Iron.

The outlook in the Scotch pig iron trade is hardly satisfactory. At the present time the output is largely taken up by shipments to America, but when these come to an end and makers have to depend on home and occasional export demand very dull times are likely. In any case the tone in the market is a trifle easier even although quotations show no change.

Steel and Iron.

Though there appears to be a little more movement in certain export directions, business in the steel and iron trades, on the whole, is of a very dull nature. Steel-makers still experience a great scarcity in orders for plates, and sections also are greatly in need of fresh business. Quotations for plates and sections are unchanged, but there is little doubt that easier prices can be secured for good specifications. Steel sheet makers have comparatively fair export demands, but home requirements are of small account. Bar iron prices are unchanged, but the works are having a very lean time. Competition for re-rolled steel bar orders is very keen. Local works can hardly compete in price, but the quality of the home article occasionally decides. The home prices of re-rolled steel bars are quoted £9 5s. home and £9 per ton export. The demand for scrap material is moderate and high prices rule.

Coal.

The Scottish collieries are well booked up at present and the nature of the demand has completely changed within a short period. A week or two ago the chief demand was for washed materials, but round fuels predominate now. Small stuffs, apart from treble nuts, have fallen off. Collieries are heavily booked for round coal for export, and at present have only small quantities available for immediate shipment. Prices are very firm, and show a further hardening tendency. Good reports are to hand concerning employment in the Lothians, fully 95 per cent. of the workmen employed having had full-time engagements during the past week or two. Aggregate shipments during the past week amounted to 341,445 tons against 290,910 tons in the preceding week, and 347,273 tons in the same week in 1913. Home markets are very dull and disappointing. House coal is fairly busy, but industrial requirements are very easily satisfied.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

LAST week the foreign coal exports from this district constituted a record for any week this year and amounted to over 698,000 tons. This fact, of course, is very encouraging, but it is doubtful whether the figure will be maintained, although it is certain that collieries are very well sold. Bad weather has interfered with the regular movement of tonnage, and as a result shipments may fall below the record established. The fact, however, remains that the coal trade is at the present moment in a better state than it has been at any time this year, with the exception possibly of the period when the American and Canadian demand was at its highest. The inquiry is more widespread and the shipments are more distributed; the conditions in this respect are in fact more pre-war in character than they have been since 1914. Furthermore, no serious trouble is now anticipated on the non-unionist question and the Ebbw Vale dispute has been settled, each of which facts has a heartening effect and is calculated to restore confidence. One unusual feature, so far as post-war conditions are concerned, is that quite a number of collieries are pretty fully stemmed, not only for this month, but for the early part of December, which is, of course, a short month. There is also some talk of business over next year, but up to the present time it does not appear that coalowners have definitely formulated ideas regarding prices. In normal times quite a considerable amount of business would have been transacted by the end of October for shipment over the following year, but the prevailing conditions have not become sufficiently settled for merchants and consumers to operate so far ahead. The risks are regarded as too great. The position abroad is a very material factor and financial questions are a vital issue. The adverse foreign exchanges so far as Italy and France are concerned are proving a serious handicap to business, which makes one think that even the existing good conditions in the coal trade may receive a setback before very long, as Italy and France are two of the most important customers of this district. It is very fortunate that the colliery companies have got so much business on their books already, as the unfavourable foreign exchanges are checking operations and exporters have to be more careful than ever respecting the risks they take.

Ebbw Vale Dispute.

Since I wrote last week the details of the settlement of the Ebbw Vale dispute have been made known. One of them was that the collieries should be reopened for work on Monday last. This condition was duly observed; but, of course, it will be some time before the resumption of full operations will be possible, and it will be a longer time before the steel works can be re-started. It was also provided that the management and the representatives should proceed to discuss at once the question of allowances, and if they failed to come to an agreement that the matter should be referred to Dr. Galloway for his decision, and that his award should be accepted by both sides. A month is allowed for the above procedure, and Dr. Galloway's award will become operative from December 3rd. Any other matters about which there may be differences of opinion are to be dealt with in accordance with the provisions of the Conciliation Board agreement. The agreement that has been come to does not strike one as having all the elements of permanency about it, more especially as the advisory agent of the Ebbw Vale miners has, since the terms were published, publicly stated that there could be nothing permanent about the Galloway award, because what the men wanted was a new price list. His view was that the award would mean continual strife between the men and the officials as to the amount of the allowance to be paid.

Non-unionist Question.

The extent to which the instruction of the Executive Council of the South Wales Miners' Federation that the miners should tender fourteen days' notices on the non-unionist question on October 23rd proved unsuccessful is shown by an official statement issued by the secretary of the Coalowners' Association. It appears that returns were received from 282 collieries at which 195,361 workmen were employed. At 81 collieries no notices were given, and of the total number of workmen employed 55,631, or 28 per cent., gave notice. There were whole groups of collieries at which the men ignored the instruction of their leaders. The Executive Council of the Federation considered the position on Monday last, and its official report stated that the returns received showed that considerable progress had been made in the direction of reorganising the workmen, but it was decided to call a conference of the men's delegates for to-day—Friday—with a view to considering what further steps should be taken to deal with the situation.

Shortage of Orders.

Work is at a standstill at Guest, Keen and Nettlefold's steel works at Dowlais this week, and as a result there are about 3000 men idle. The company has found it necessary to close the big mill for a short time until it has more orders in hand. The blast-furnacemen are, however, still employed. In the case of the lower mill the tonnage men on the rail bank are not working, as a wage dispute has arisen affecting 200 men. There has been a considerable fall in these men's earnings of late, and a satisfactory arrangement has not been come to with the management.

Colliery Development.

The Powell Duffryn Company has struck coal at a depth of 430 yards at the sinkings at the Ogilvie Colliery at Deri, a few miles from Bargoed, in the Fochriw Valley. The surface plant has been erected and the sidings linking the colliery with the Rhymney Railway have been laid, and it is expected that the colliery, which was designed to give employment to several thousand men and to produce an output of from 2000 to 3000 tons a day, will soon be in full operation. The new colliery, like the Britannia Colliery at Pengam, will be worked entirely by electricity.

Current Business.

The tone of the steam coal market is well maintained and the inquiry has been good, but there are indications that the demand is easing down. This fact is not surprising in view of the very adverse conditions of the exchanges, as they affect Italy and France, and buyers show a disposition to hold their hands. In the case of France there appears to be some apprehension respecting future business, in view of the fact that the French railway companies have granted preferential rates on coal produced by the French mines. This concession is calculated to make it more difficult for coals from this district to compete. Best Admiralty large coals are very well sold and are steady on the basis of 28s. to 28s. 6d., but small coals are still irregular, as they are more plentiful. Anthracite coals are quite firm, especially sized qualities. Patent fuel is comparatively quiet, and the difficulties of makers are increased by the enormous price of pitch, which has reached the high figure of 120s. per ton. Ten tons of pitch are used for 100 tons of patent fuel.

Latest News from the Provinces.

LANCASHIRE.

BARROW-IN-FURNESS.

Another Furnace in Blast.

A FURNACE is being put into blast at the Barrow Iron and Steel Works, making a total of three blowing.

NORTH OF ENGLAND.

Iron and Steel Exports.

Evidence of the gradual revival of the Cleveland iron and steel trade and the recovery of lost overseas markets is afforded in the export returns for October, which show that the total exceeded 100,000 tons for the first time for over six years. The boom in the pig iron shipments to America was the chief factor, but there was also a marked improvement in the steel shipments. Last month the pig iron exports totalled 66,381 tons, of which 28,628 tons went to the United States and 9050 tons to Canada. The shipments of manufactured iron and steel reached 38,598 tons, the chief customers being India and Ceylon with 13,939 tons, Portuguese West Africa 3058 tons, and Japan 2199 tons.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

The tin-plate market is firm at 19s. 6d. basis I.C. f.o.b., and a good deal of business has been done. Recently substantial increases in the assessments of tin-plate works in Swansea and the district have taken place. Works were formerly assessed on output, but now it will be on the flat rate basis per mill. This will mean increased working costs per mill, but it is calculated that the advance will not be sufficient seriously to handicap the industry, though makers will naturally stiffen their ideas regarding prices.

Miners' Wages.

There will be no advance in the wage rate of South Wales miners for this month as was expected. The joint auditors' report for September shows an available surplus sufficient only to pay 19.55 per cent. on the standard rates. Wages will consequently be on the minimum of 28 per cent. on the 1915 standard as guaranteed.

SCIENTIFIC BOOKS FOR BLIND READERS.—If any of our readers should happen to have blind friends who are interested in scientific subjects, they should make a note of the fact that the National Institute for the Blind publishes many scientific works which can be obtained from the headquarters at 224, Great Portland-street, London, W. 1. Amongst the titles of books now available in Braille we note the following:—"Electricity and Magnetism," four volumes; "Geology," one volume; "Primer of Astronomy," three volumes; "Botany," one volume; "Modern Chemistry," two volumes; "Sound and Music," two volumes; "Soap Bubbles," one volume; "Zoology," one volume; "Anthropology," two volumes; "Heat," three volumes; "Coming of Evolution," two volumes; "Mechanics," three volumes.

CONTRACTS.—Alldays and Onions, Limited, of Birmingham and London, have received an order from the General Post Office for 1500 pedal cycles.—Yarrow and Co. (1922), Limited, have secured the order for the boilers required by the Brighton Corporation for the extension to its Southwick power station. The boilers are to be of the Yarrow land type, with superheater.—Vickers Limited have received an order to build an exceptionally large steel frame jaw crusher to be erected at the Cargo Fleet Iron Company's Wensley Quarries. The main frame of the crusher will be built up in sections for transport purposes, and the machine will be used for breaking down large blocks of limestone at the mine.—The Spearing Boiler Company, Limited, has been successful in securing a contract for two water-tube boilers of 30,000 lb. each from the Watford Corporation.—In connection with the electrification of a portion of the line between Durban and Johannesburg, large orders have been secured for this country against strong competition. Included in the contracts placed is an order for the machinery for the substations to be located between Pietermaritzburg and Glencoe, a distance of approximately 175 miles. This order, covering twenty-one 2000 K.W. motor generator sets for 3000 volt D.C. service, together with switchgear, automatic control gear, auxiliary transformers, &c., has been secured by the British Thomson-Houston Company, Limited, and will be manufactured in England at their Rugby and Willesden works, the approximate value being £400,000. The consulting engineers to the South African Railways and Harbours Administration in connection with this work are Messrs. Merz and McLellan, of London and Newcastle.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 7 6	—
No. 1 Foundry	5 2 6	—
No. 3 Foundry	4 17 6	—
N.E. Coast—		
Hematite Mixed Nos.	4 13 0	4 13 0
No. 1	4 13 6	4 13 6
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 10 0	4 10 0
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 12 6	—
(3) Lincolnshire—		
Basic	4 0 0	—
Foundry	4 2 0	—
Forge	4 0 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 5 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. Coast—		
Crown Bars	10 10 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	12 10 0	—
Hoops	14 0 0	—
Midlands—		
Crown Bars	10 10 0 to 10 15 0	—
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 12 6 to 9 15 0	
Gas Tube Strip	10 10 0 to 10 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	12 10 0	—
Ship Plates ⅜in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ⅛in. to ⅜in.	10 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 12 6

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	13 10 0	—
Hard Billets	8 5 0	—
Soft Billets	7 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 0 0	—
Light ,,	10 10 0 to 11 10 0	
Billets	9 0 0	—
Manchester—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lanca. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 5 0	—
Soft ,,	7 5 0	—
Hoops	11 15 0	—
Soft Wire Rods	10 0 0	—
Midlands—		
Small Rolled Bars	8 15 0	—
Billets and Sheet-bars	6 17 6 to 7 0 0	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 10 0 to 17 0 0	
Angles	8 15 0	—
Joists	9 0 0 to 9 10 0	
Tees	10 0 0	—
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/6
Block Tin (cash)	181 0 0
,, (three months)	181 10 0
Copper (cash)	63 0 0
,, (three months)	63 12 6
Spanish Lead (cash)	26 17 6
,, (three months)	25 7 6
Spelter (cash)	37 7 6
,, (three months)	35 10 0
Manchester—	
Copper, Best Selected Ingots	66 10 0
,, Electrolytic	71 0 0
,, Strong Sheets	66 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	28 5 0
,, Foreign	27 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton. £	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£30	12/-
,, 6 p.c. to 8 p.c. ,,	£22 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£21 10 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£55 0 0	26/-
,, ,, 1 p.c. ,,	£68 0 0	30/-
,, ,, 0·75 p.c. carbon	£75 0 0	37/-
,, carbon free	1/7 per lb.	
Metallic Chromium	4/9 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 2 6 scale 5/- per unit	
,, ,, 75 p.c.	19 10 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	8/- per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

	Scotland.	Export.
Lanarkshire—		
(f.o.b. Glasgow)—Steam		24/-
,, ,, Ell		25/6
,, ,, Splint		25/6 to 27/6
,, ,, Trebles		23/6
,, ,, Doubles		22/-
,, ,, Singles		18/6
Ayrshire—		
(f.o.b. Ports)—Steam		24/-
,, ,, Splint		25/6
,, ,, Trebles		23/6
Fifeshire—		
(f.o.b. Methil or Burntisland)—Steam		22/- to 26/-
Screened Navigation		28/-
Trebles		24/6
Doubles		22/-
Singles		19/6
Lothians—		
(f.o.b. Leith)—Best Steam		24/6
Secondary Steam		23/6
Trebles		24/-
Doubles		22/6
Singles		20/-
	England.	
(5) N.W. Coast—		
Steams		29/6
Household		46/6 to 57/6
Coke		34/-
Northumberland—		
Best Steams		26/- to 27/-
Second Steams		24/- to 24/6
Steam Smalls		15/- to 16/6
Unscreened		20/6
Household		25/- to 28/-
Durham—		
Best Gas		24/- to 24/6
Second		22/- to 22/6
Household		25/- to 28/-
Foundry Coke		37/- to 40/-
Sheffield—	Inland.	
Best Hand-picked Branch	32/6 to 34/6	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	24/- to 25/-	—
,, ,, House	21/6 to 22/6	—
,, ,, Large Nuts	18/6 to 20/6	—
,, ,, Small ,,	15/- to 16/6	—
Yorkshire Hards	20/- to 21/-	—
Derbyshire ,,	19/- to 20/6	—
Rough Slacks	8/6 to 10/6	—
Nutty ,,	7/6 to 8/6	—
Smalls	3 - to 5/-	—
Blast Furnace Coke (inland and Export)		21/- to 30/-

	(9) South Wales.
Cardiff—	
Steam Coals:	
Best Smokeless Large	28/- to 28/6
Second ,, ,,	27/- to 27/6
Best Dry Large	28/- to 29/-
Ordinary Dry Large	27/6 to 28/-
Best Black Vein Large	25/6 to 26/6
Western Valley ,,	25/6 to 26/-
Best Eastern Valley Large	24/6 to 25/-
Ordinary ,, ,,	22/6 to 24/6
Best Steam Smalls	16/- to 17/-
Ordinary ,,	12/- to 14/-
Washed Nuts	25/- to 30/-
No. 3 Rhondda Large	28/- to 29/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	22/- to 23/-
,, ,, Through	18/6 to 21/-
,, ,, Smalls	12/- to 14/-
Coke (export)	37/6 to 42/6
Patent Fuel	27/- to 30/-
Pitwood (ex ship)	30/6 to 31/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	57/6 to 60/-
Seconds	45/- to 50/-
Red Vein	40/- to 45/-
Machine-made Cobbles	70/- to 72/6
Nuts	72/6 to 75/-
Beans	42/6 to 45/-
Peas	21/6 to 23/-
Breaker Duff	9/- to 9/6
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	25/- to 27/6
Seconds	23/- to 25/-
Smalls	12/- to 14/-
Cargo Through	18/- to 22/6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.
(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Customs Reform.

In 1916 the Government was authorised to modify the import duties from time to time by means of coefficients which were intended to adjust them to the variations of money values. The system might have proved satisfactory if there were any real basis for fixing the coefficients and if they were established with the sole idea of placing the tariffs relatively at their pre-war level. The first difficulty encountered was the opposition of manufacturing interests to the pre-war values, which were based upon the arbitrary estimations of the Customs Commission. They are considered to be much below the factor of appreciation as now applied to foreign goods, of which the actual values have to be declared by importers at the ports of entry—that is to say, including all freight and other charges. It is therefore argued that the coefficients do not represent a fair adjustment according to the present system of valuation. Again, in establishing the coefficients the Minister of Commerce has found it necessary to consult the various industrial groups, which are all agitating for an increase sufficient to protect their particular industries. To a great extent, therefore, the coefficients are regarded more and more as an instrument of protection, and there is no doubt that the duties would have been considerably advanced if it were not for the restraining hand of the Government. Some months ago the Customs Commission completed a revised list of coefficients, but it is being held up pending its examination by the various industrial groups. It appears even quite possible that the system will be abandoned. The period during which the Government has a right to adjust coefficients expires at the end of this year, and it is understood that the Minister of Commerce has no intention of asking for its renewal. The Federation of Mechanical and Electrical Engineering Firms and Metallurgists is urging upon the Government the necessity of reforming completely the tariffs by, first of all, establishing a much more complete and accurate classification and then by adapting the import duties in such a way that they will afford adequate protection to home industries. The whole matter will shortly come up for debate in the Chamber of Deputies, when it appears fairly certain that a reform of the tariff system will be approved of in principle; but, in view of the magnitude of the task, the coefficients will remain in operation for some time to come, with certain increases that will give partial satisfaction to manufacturers.

Trade Policy.

While the engineering and iron and steel industries are endeavouring to secure effective protection against foreign competition, the commercial groups are agitating for a more liberal policy, and at the Congress on Foreign Trade held at Marseilles during the week, resolutions were passed showing that the commercial classes regard the present tendency towards greater protection as fatal to any chances of economic recovery. It was pointed out that prosperity depends entirely upon the development of foreign trade. It is quite a fallacy to think of making the country self-supporting, and nothing is to be gained by protecting home industries and refusing to buy abroad. Nearly all the essentially French manufacturing industries are languishing because the export trade in manufactured goods is dwindling almost to vanishing point. Therefore, as business must be done with foreign markets, there is no alternative but to pursue the policy of commercial arrangements, although on much broader lines than have been followed up to the present time. The only way of doing this is to offer sufficient reciprocity, and this must mean the abandonment of the protection afforded to certain industries that can hardly have more than a precarious existence and are responsible for the excessive cost of some classes of manufactured goods in this country. A liberal system of reciprocity would allow of foreign countries doing business here and enable French firms to sell their special products abroad. The Marseilles Congress could see no way out of the difficulty except for Government to formulate a definite commercial policy which would take into account the general interests of the country rather than the particular requirements of some manufacturing industries. With the reopening of trade by means of a reciprocal policy it will be necessary to accord facilities in the way of credits, and a scheme was presented by the Congress, a feature of which is that certain financial houses undertake to give their assistance. Judging from recent developments, it would appear that the financial groups are quite prepared to aid the work of commercial expansion on condition that the existing restrictions to foreign trade are removed. The forthcoming debate in the Chamber of Deputies will doubtless show to what extent this will be done.

Bridge Contracts.

What will, it is declared, be the most costly bridge for its size in the world will be the one to be constructed to take the place of that portion of the Batignolles tunnel which passed under the Boulevard des Batignolles, outside the St. Lazare Station in Paris. The demolition of the tunnel stops at the boulevard because at that point it passes under a complicated system of mains, as well as under the Metropolitan Railway, which have all to be carried over the new bridge. Its general design is a girder bridge with a tunnel for the Metropolitan in the centre and a series of tunnels on each side for the water, gas, compressed air, electric and other mains. The contract for the work has just been given out, and the work is expected to be completed in two years. The cost of 20 million francs will be borne by the State Railways. The high cost of this short bridge, which will merely cross the railway, is due to the preliminary work of displacing the mains and demolishing what is left of the Batignolles tunnel. Another bridge contract has been secured by the Chantiers et Ateliers de la Gironde, which are to build a suspension bridge across the lagoon of Santa Fé, at Setubal, in the Argentine Republic. The bridge will have a span of 294 m. and a width of 9.40 m. As a rule bridge builders have been fairly busy, chiefly for railways, but there is now little work coming forward to replace completed contracts.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

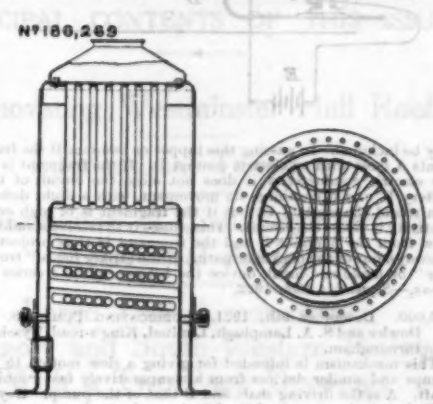
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

186,269. November 11th, 1921.—Vertical Boilers, R. L. K. Hazell, 23, Lexden-street, Lexden, Essex, and Davey, Paxman and Co., Limited, Colchester.

In this specification claim is made for a steam generator having a plurality of approximately horizontally disposed rows of water tubes in the fire-box, the tubes of each row being arranged in



two or more groups and the tubes of each group being of segmental shape with varying arcs, and a plurality of vertically or approximately vertically arranged smoke tubes passing through the water and steam space and connecting the fire-box with a common smoke box forming the top of the generator. The shell is jointed circumferentially to facilitate access to the water tubes.—*September 28th*, 1922.

TRANSFORMERS AND CONVERTERS.

186,289. October 12th, 1921.—Improvements in and relating to Casings for Transformers and other Electrical Apparatus, *The British Thomson-Houston Company, of Crown House, Aldwych, W.C.* 2.

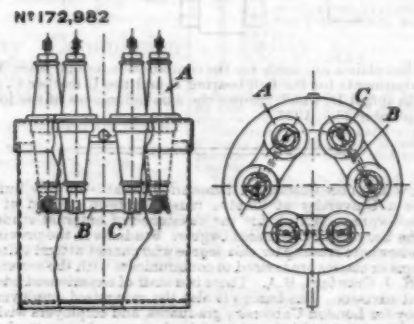
On top of the main casing of the transformer there is an auxiliary expansion casing A and a "breather" B. On account of the restricted passage C, the hot oil cannot readily pass from

the main casing to the auxiliary casing without being cooled. At intervals the receptacle D is drained so as to remove any moisture. The oil in the auxiliary casing is maintained relatively cool, and sludging by reason of the oil surface being in contact with the air is avoided.—*September 28th*, 1922.

SWITCHGEAR.

172,982. December 17th, 1920.—Improvements in and relating to Oil Switches, Sachsenwerk Licht und Kraft Aktiengesellschaft, of Niedersedlitz, near Dresden, Germany.

The leading-in insulators A are arranged in a circle and form

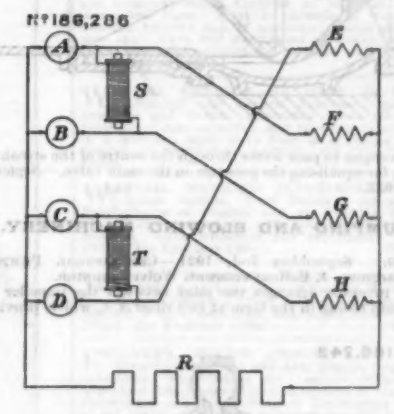


a hexagon. The switch blades B connect the contacts C of each two successive insulators A, and a complete utilisation of the space of the vessel is thus obtained. The insulators may also be arranged on arcs of different diameters and the sides of the figures formed need not be equal.—*September 28th*, 1922.

DYNAMOS AND MOTORS.

186,286. March 28th, 1922.—Improvements in and relating to Braking Systems for Dynamo Electric Machines, *The British Thomson-Houston Company, Limited, of Crown House, Aldwych, W.C.* 2.

This invention relates to the rheostatic braking of direct-current multi-motor electric traction sets, and more particularly to those sets in which the motors are connected in pairs, the armature of one motor being connected in series with the field winding of the other motor, and the set of motors being connected in parallel. In the drawing, A B C D are the armatures, and E F G H the corresponding field windings of the four motors of the set. R is the brake resistance ordinarily used. S and T

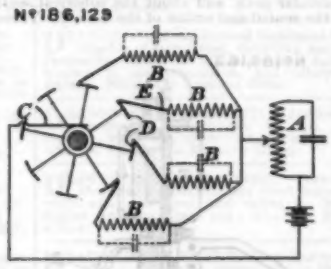


are two choke coils which act as valves and eliminate the circulation of alternating or pulsating currents. Under the old system of rheostatic braking, all the armatures connected in parallel were in series with the field windings, which were themselves in parallel. According to the new system each armature is directly in series with the field winding of another motor, and all the armatures and field windings are grouped in parallel, the valves, in the form of induction coils, being connected between the positive terminals of armatures A and B, and C and D respectively. Experiments have shown that equipotential connections not only allow equalising currents to pass, but also eddy currents between the armatures, and the intensity of the latter is often very high. The object of the invention is to obviate these disadvantages.—*September 28th*, 1922.

TELEGRAPHS AND TELEPHONES.

186,129. June 16th, 1921.—Improved Means for Producing Alternating Electric Currents, Henry Joseph Round, of 9, Woodberry-crescent, Muswell Hill, London, N.

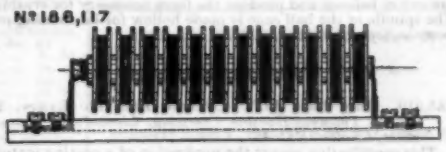
In the accompanying drawing A is an oscillatory circuit connected to a number of resistances B, and to one pole of a battery, the other pole of which is connected to a brush C bearing on a slip ring connected to a number of conducting bars D on which rub brushes E, each brush being connected to one of the resistances. In some cases it is preferable to shunt each resistance



by a condenser. The resistances may include vacuum valves or similar devices which will tend to prevent back surges of the current. It is well known that an oscillatory circuit can be maintained in oscillation if the bars of a rotary commutator are caused to pass beneath the brushes at a frequency which is either the same as the natural frequency of the circuit or some multiple thereof, and the object of this invention is to provide apparatus of this sort which will work without excessive arcing and sparking at the brushes.—*September 18th*, 1922.

186,117. June 15th, 1921.—Improvements in Electric Resistances, Sydney George Frost, of the Air Ministry, Kingsway, London.

This specification describes electric resistances which are particularly suitable for use as grid leaks for thermionic valves. The resistances are built up of a plurality of units each con-



sisting of a spool of di-electric material wound with insulated resistance wire, and means are provided for disconnecting one unit from another, so that a resistance of any desired value may be readily assembled, and in the event of a short circuit occurring in any section, that section can be replaced without destroying the whole resistance.—*September 15th*, 1922.

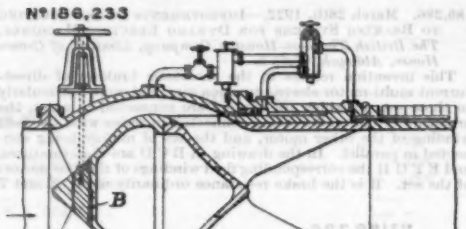
TRANSMISSION OF POWER.

186,233. August 26th, 1921.—Large Hydraulic Valves, P. W. Seewer, Bracknell, Lynton-road, New Malden, Surrey.

In this stop valve, which is intended for large hydraulic installations, the flow is changed from the solid cylindrical into annular form by the well-known system of inserting a stream line

casting in its path, but instead cutting off the water by moving part of the casting to close the opening, a sleeve A is arranged to slide forward to shut the valve. By these means, it is claimed, the overall dimensions of the valve can be reduced. A by-pass

No 186,233



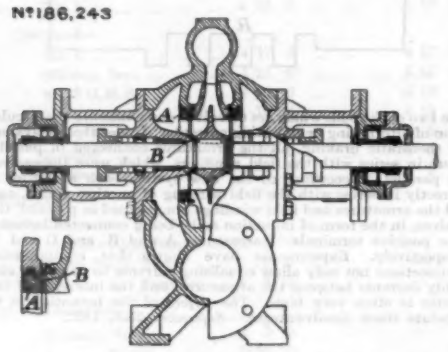
B is arranged to pass water through the centre of the streamline casting for equalising the pressure on the main valve.—*September 28th*, 1922.

PUMPING AND BLOWING MACHINERY.

186,243. September 2nd, 1921.—Centrifugal Pumps, J. Hargrove, 4, Balfour-crescent, Wolverhampton.

The inventor arranges the joint between the impeller and the pump casing in the form of two rings A A, which provide a

No 186,243



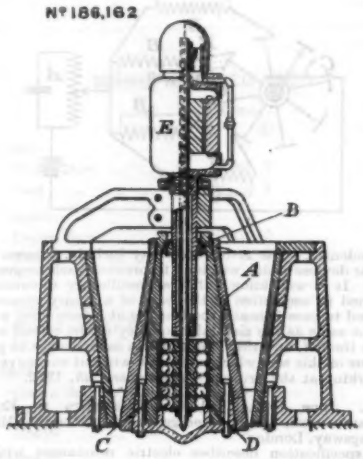
rubbing face that lies in a plane normal to the axis. He claims that such rings are more easily adjusted than the usual type. He also secures the impeller on the shaft by means of a split ring B.—*September 28th*, 1922.

CRUSHING AND GRINDING.

186,162. June 22nd, 1921.—An Ore Crusher, B. A. Mitchell Garfield, Salt Lake, Utah.

In this crusher the moving part A is given a swinging motion round a circular path, and about the spherical seating B, by means of the centrifugal action of the balls C. These balls are

No 186,162



rotated at a high speed by the cage D, which is driven by the motor E, and as they are only placed on one side of the cage they are out of balance and produce the force necessary for crushing. The spindle of the ball cage is made hollow for lubricating purposes.—*September 22nd*, 1922.

MISCELLANEOUS.

185,910. July 18th, 1921.—Coating Electric Lamps, *The British Thomson-Houston Company, Limited*, 83, *Cannon-street, London, E.C.* 4.

This specification covers the production of a coating material for glass or other vitreous surfaces, which is said to be resistant to heat. The body of the coating material is peptised—that is to say, changed from a solid state into a permanent colloidal suspension—by the addition of hydroxyl ions. A typical mixture given in the specification is as follows:—

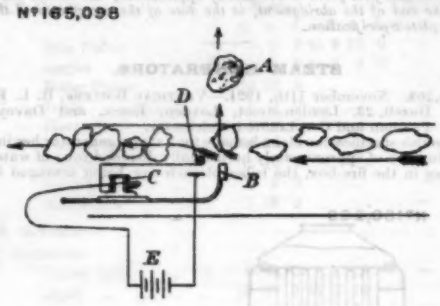
Kaolin	0.549 lb.
Magnesium oxide	0.108 lb.
Alumina	0.638 lb.
Zirconium oxide	0.108 lb.
Sodium hydrate	0.0035 lb.
Sodium silicate	4.380 lb.
Amyl alcohol	0.0016 gallon
Water	0.546 gallon

The mixture is sprayed on, and is followed by a fixing solution of 20 per cent. zinc chloride and 10 per cent. aluminium sulphate. —*September 21st*, 1922.

165,098. June 2nd, 1921.—Improvements in Apparatus for Separating or Sorting Fragmentary Materials by Electric Conductivity, Henri Louis Adrien Schweitzer, of Saint-Albain (Saône et Loire), France.

The fragments A are laid out in line either on a movable conveyor, or on an inclined plane which is arranged so that the fragments can only travel one by one through a plane perpendicular to their movement in the direction of the arrow past a tapper B. The latter is actuated by an electro-magnet C which attracts an armature attached to the shank of the tapper. A make-and-break device, like that of an electric bell,

No 165,098

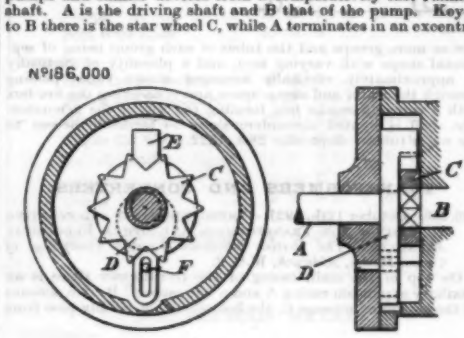


may be included. In passing this tapper or hammer B the fragments A meet with an electric contact D. If the fragment is of low electric conductivity it does not close the circuit of the battery E, and it continues its movement, with a slight deflection round the contact D, but if the fragment is of high conductivity it closes the circuit. This causes it to receive a sudden blow from the hammer B and the fragment is thus projected sideways, out of the conveyor path. If the striker has a "trembler" or make-and-break device the hammer gives a series of blows.—*September 20th*, 1922.

186,000. December 9th, 1921.—Lubricating Pumps, S. C. Dowler and S. A. Lamplugh, Limited, King's-road, Tyseley, Birmingham.

This mechanism is intended for giving a slow motion to oil pumps and similar devices from a comparatively fast running shaft. A is the driving shaft and B that of the pump. Keyed to B there is the star wheel C, while A terminates in an excentric

No 186,000

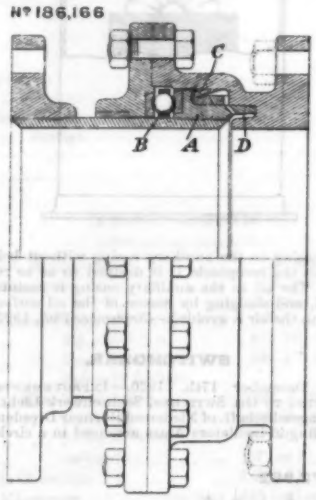


D. The pawl E, which engages with the star wheel, embraces the excentric and is prevented from rotation by the pin F. The pawl receives an oscillating movement from the shaft A and moves the shaft B round a tooth at a time for each revolution of A.—*September 21st*, 1922.

186,166. June 24th, 1921.—Rotatable Pipe Joints, W. H. Dorman and Co., Limited, 43, Foregate-street, Stafford, and O. H. G. Steed, 88, Tixall-road, Stafford.

The construction of this joint is shown so plainly in the drawing that it needs no description, but it should be pointed

No 186,166



out that claims are made for the combination, in one piece A, of the abutments for the ball bearing B and the U leather C, and for the spigot D, which ensures the axial alignment of the joint. —*September 25th*, 1922.

New London Commerce Degree Bureau.—A new bureau under a University of London trust has been opened at 46, Russell-square, W.C. 1, for the assistance of external students for the University Commerce Degree. Students in the provinces and elsewhere reading for this degree who cannot attend suitable colleges or classes are invited to communicate with the secretary, Mr. H. J. Crawford, B.A. There is a staff of experienced educational advisors. The bureau is also the recognised employment agency for London University graduates, and employers wishing to get in touch with London-trained men and women should make their wants known to the secretary. The bureau's charges are small, as it is not a profit-making body. Prospectuses may be had from the Secretary.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

The Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Extra general meeting. Lecture on "Repairs to the Roof of Westminster Hall," by Sir Frank Baines. 6 p.m.

The Association of Engineering and Shipbuilding Draughtsmen.—Memorial Hall, Farringdon-street, E.C. 4. "Adult Education," by Lord Haldane. 7 p.m.

The Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Laminated Springs," by Mr. T. H. Sanders. 7.30 p.m.

West of Scotland Iron and Steel Institute.—Royal Technical College, George-street, Glasgow. Paper, "Low Temperature Gas Producers," by Mr. N. E. Rambush. 7 p.m.

North of England Institute of Mining and Mechanical Engineers.—Neville Hall, Newcastle-upon-Tyne. Joint meeting with the Institution of Civil Engineers. 7 p.m.

FRIDAY TO SATURDAY, NOVEMBER 3RD TO 11TH.

Sixteenth International Motor Exhibition at the White City and Olympia.

SATURDAY, NOVEMBER 4TH.

Institution of British Foundrymen: Lancashire Branch.—College of Technology, Manchester. Paper, "The Manufacture of Coke for Industrial Purposes." Part II., "Requirements of the Iron Trades; Results of Recent Researches." 4 p.m.

MONDAY, NOVEMBER 6TH.

Royal Institution of Great Britain.—Albemarle-street Piccadilly, W. 1. General meeting. 5 p.m.

The Society of Engineers.—Burlington House, Piccadilly, W. 1. Paper, "The Atlantic Cruise of H.M. Airship R 34," by Mr. E. E. Turner. 5.30 p.m.

Institute of Transport.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Paper, "British Railway Operating Statistics and their Lessons," by Sir W. M. Acworth. 5.30 p.m.

TUESDAY, NOVEMBER 7TH.

The Institution of Civil Engineers.—Great George-street, S.W. 1. Presidential address, by Dr. W. H. Maw. 6 p.m.

Institution of British Foundrymen: Burnley Section.—Municipal College, Ormerod-road, Burnley. Paper, "The Making of Moulding Boxes for the Jobbing Foundry; also Gating and Feeding of Castings," by Mr. C. Bickerton. 7.15 p.m.

The Institution of Electrical Engineers: North Midland Centre.—Hotel Metropole, Leeds. Opening meeting and smoking concert. 6.45 p.m.

The Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Paper: "Nickel, its Properties and Uses," by Mr. W. R. Barclay. 7 p.m.

WEDNESDAY, NOVEMBER 8TH.

Chadwick Public Lectures.—Textile Institute, St. Mary's Parsonage, Manchester. "Ventilation in Mills and Factories, with Demonstrations of the Kata-thermometer," by Professor Leonard Hill, M.D., F.R.S.

The Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Wireless Section meeting. "The Effect of Local Conditions on Radio Direction Finding Installations," by Messrs. R. L. Smith-Rose and R. H. Barfield. 6 p.m.

The Royal Society of Arts.—John-street, Adelphi, W.C. 2. Address, "The Value of Strikes and Lock-outs," by Lord Askwith. 8 p.m.

THURSDAY, NOVEMBER 9TH.

The Women's Engineering Society.—26, George-street, Hanover-square, W. 1. Lecture: "Research," by Mr. A. P. M. Fleming. 6.15 p.m.

The Optical Society.—Imperial College of Science and Technology, South Kensington, S.W. 7. "The History of the Photographic Lens," by Dr. R. S. Clay. 7.30 p.m.

Institute of Metals: London Local Section.—Royal School of Mines, South Kensington, S.W. 7. Address, "The Production of Large Crystals of Aluminium and some of their Properties," by Professor H. C. H. Carpenter. 8 p.m.

The Institution of Civil Engineers: Birmingham and District Association.—The Medical Institute, Edmund-street, Birmingham. Presidential address by Mr. J. E. Swindlehurst. 6 p.m.

FRIDAY, NOVEMBER 10TH.

The Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "The Development of Ball and Roller Bearings," by Mr. A. W. Macaulay. 7.30 p.m.

The Institute of Metals: Sheffield Local Section.—Mappin Hall, St. George's-square, Sheffield. Chairman's address by Professor C. H. Desch. 7.30 p.m.

TUESDAY, NOVEMBER 14TH.

Institute of Marine Engineers.—85–88, The Minories, Tower-hill, E. 1. "The Evolution of the Nobel-Diesel Engine," by Mr. G. J. Steinheil. 6.30 p.m.

WEDNESDAY, NOVEMBER 15TH.

Liverpool Engineering Society.—Royal Institution, Colquitt-street, Liverpool. Paper, "Stability of a Pile Wharf," by Mr. S. H. Ellis. 8 p.m.

FRIDAY, NOVEMBER 17TH.

The Institute of Chemistry.—The dinner arranged for Friday, November 17th, is postponed on account of the General Election.

Correction.—Influence of the Depth of Water on the Speed of Battleships, October 20th, page 416. For "less" in the tenth line from the end of the penultimate paragraph read "greater."

Bolton Corporation Turbo-alternator Set.—Messrs. Escher-Wyss have asked us to state that the turbine for the Bolton 12,000-kilowatt generating set, illustrated in our issue of April 28th, was built by them, and that only the alternator alone constructed by the Metropolitan-Vickers Electrical Company.